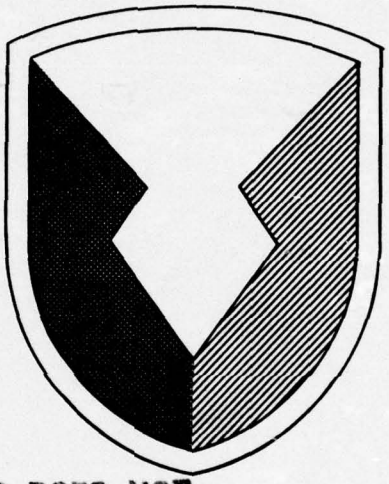
AD-A033 205 ARMY AVIATION TEST BOARD FORT RUCKER ALA F/G 1/3
MILITARY POTENTIAL TEST OF COMMERCIAL 'OFF THE SHELF' HELICOPTE--ETC(U)
JAN 64 W S DAVIS, H G SMITH

UNCLASSIFIED NL

1 OF 4
AD A033205

# US ARMY TEST & EVALUATION COMMAND







REPORT OF TEST

USATECOM PROJECT NO. 4-3-1000-01-A

MILITARY POTENTIAL TEST OF COMMERCIAL "OFF-THE-SHELF" HELICOPTERS AS PRIMARY HELICOPTER TRAINERS

[redacted]

Merle A. Claxsaddle
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US ARMY

AVIATION TEST BOARD

FORT RUCKER, ALABAMA

UNITED STATES ARMY AVIATION TEST BOARD
Fort Rucker, Alabama

(12) 295 p.

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(11) 15 JAN 1964

REPORT OF TEST

(6) USATECOM PROJECT NO. 4-3-1000-01-A

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UNITED STATES ARMY AVIATION TEST BOARD
Fort Rucker, Alabama

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MILITARY POTENTIAL TEST OF COMMERCIAL "OFF-THE-SHELF"

HELICOPTERS AS PRIMARY HELICOPTER TRAINERS

Table of Contents

UNITED STATES ARMY AVIATION TEST BOARD
Fort Rucker, Alabama

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## MILITARY POTENTIAL TEST OF COMMERCIAL "OFF-THE-SHELF" HELICOPTERS AS PRIMARY HELICOPTER TRAINERS

## CODE SHEET

This code sheet and the attached photographs will be removed when this report is distributed outside the Department of Defense.

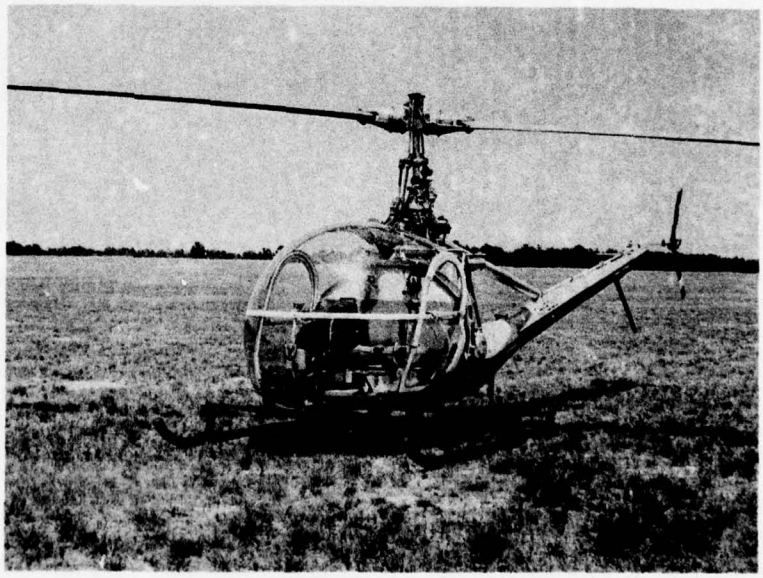
| Code | Helicopter Designation |
|---|---|
| PH-1 | Hughes 269A |
| PH-2 | Brantley B2A |
| PH-3 | Brantley B2B |
| PH-4 | Hiller UH-12E |
| PH-5 | Bell 47G3B1 |
| PH-6 | Bell 47G2A1 |
| PH-7 | Hiller UH-12L |
| PH-8 | Enstrom F-28 |
| PH-9 | Hughes 269A-1 |

| | Manufacturer |
|---|---|
| Company A | Hughes Tool Company, Aircraft Division |
| Company B | Hiller Aircraft Company |
| Company C | Bell Helicopter Company |

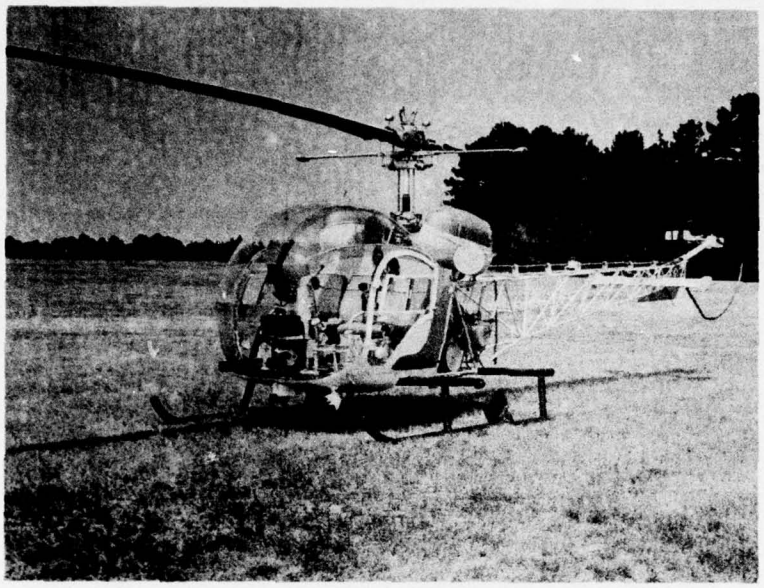
PH-1

PH-9

PH-4



PH-7



PH-5

PH-6

UNITED STATES ARMY AVIATION TEST BOARD
Fort Rucker, Alabama

# REPORT OF TEST

## USATECOM PROJECT NO. 4-3-1000-01-A

## MILITARY POTENTIAL TEST OF COMMERCIAL "OFF-THE-SHELF" HELICOPTERS AS PRIMARY HELICOPTER TRAINERS

## PART I - GENERAL

A. References. A list of references is contained in part III, appendix B.

B. Authority.

1. Directive. Message TT 11128, Headquarters, USATECOM, 28 June 1963.

2. Purpose. To determine which commercial "off-the-shelf" FAA-certificated helicopters are suitable for use as primary helicopter trainers.

C. Background.

1. In order to alleviate an existing shortage of observation helicopters in tactical units throughout the Army, the Office, Deputy Chief of Staff for Operations (DCSOPS), proposed to replace the UH-23( ) helicopters presently used at Fort Wolters, Texas, for primary helicopter training with low-cost, off-the-shelf helicopters. After this concept was staffed and approved at the Department of Army and Defense levels, DCSOPS directed the US Continental Army Command (USCONARC) to submit a Statement of Requirement for a commercially-produced, low-cost, off-the-shelf helicopter to replace tactical helicopters presently in use as primary helicopter trainers at the US Army Primary Helicopter School (USAPHS). In compliance with the directive, USCONARC prepared and submitted the Statement of Requirement in December 1962. In February 1963, the Director of Army Aviation, Office, DCSOPS, forwarded the approved Statement of Requirement, as amended, to the Commanding General, US Army Materiel Command (USAMC), for

evaluation and procurement of an off-the-shelf primary helicopter trainer. The CG, USAMC, approved a recommendation of the US Army Mobility Command (USAMOCOM) to establish a two-step procurement program, Invitation for Bids (IFB). Step One of the two-step program consisted of a request for technical proposals from industry, the response of the bidders to the request, and the evaluation by the US Army Test and Evaluation Command (USATECOM) of the bidder's helicopter and technical proposals to determine the acceptability of the helicopters offered. Step Two consists of a formal procurement, in which bid prices will be submitted. Competition in the second step will be strictly confined to the bidders whose helicopter and technical proposals were found acceptable. Step One of the IFB was prepared by the US Army Aviation and Surface Materiel Command (USAAVSCOM) and mailed on 17 May 1963. Delivery to the US Army Aviation Test Board (USAAVNTBD) of one production model helicopter, with a manufacturer's written technical proposal of the configuration which will meet the model specification, was scheduled for 30 days after receipt of Step One of the IFB by industry. To expedite tests, the schedule of deliveries of the test helicopters was arranged as follows:

| | |
|---|---|
| PH-1 | 10 June 1963 |
| PH-2 | 21 June 1963 |
| PH-3 | 9 July 1963 |
| PH-4 | 25 July 1963 |
| PH-5 | 3 August 1963 |
| PH-6 | 14 August 1963 |
| PH-7 | 30 August 1963 |
| PH-8 | 3 September 1963 |
| PH-9 | 12 September 1963 |

2. During the initial staffing and coordination of this program at the Department of the Army level, it was concluded by the Office, Assistant Secretary of the Army for Installations and Logistics (OASA-I&L), that a limited pre-procurement evaluation conducted by the USAAVNTBD and the USAPHS at Fort Rucker, Alabama, would save

time, reduce overall grogram cost, and produce the desired information required for Step Two of the program. However, OASAI&L agreed that if the evaluation revealed a low-cost usable trainer consistent with the program concept but doubt existed as to its mission suitability, a post-procurement evaluation would be conducted at Fort Wolters, Texas, using the helicopter in question under actual student training conditions. Further, should results of such an evaluation find that a light, inexpensive helicopter does not fulfill the primary training requirement, further procurement would be terminated.

3. Prior to the completion of the test, the PH-2, PH-3, and PH-8 were withdrawn by the manufacturers on 5 July, 23 July, and 16 September 1963, respectively. The remaining helicopters were subjected to a 60-flying-hour test. Testing was completed on 4 October 1963.

D. Description of Materiel. Descriptions of each test helicopter are contained in part II.

E. Test Objectives.

1. The USAAVNTBD evaluated each helicopter to determine:

a. Whether each helicopter met the Model Specification.

b. Whether each helicopter met the Statement of Requirement.

c. Whether the physical characteristics and overall configuration of each helicopter were suitable.

2. Experienced primary flight instructors from the US Army Primary Helicopter School conducted primary flight training with qualified student officers with no previous flight experience, and transition training for rated Army aviators with varied experience in observation helicopters. The helicopter was repeatedly flown through typical training missions while the students performed maneuvers included in the approved flight syllabus of the US Army Primary Helicopter School, Fort Wolters, Texas. The following areas were evaluated:

a. Adequacy of flight controls.

b. Stability.

c. Power reserve.

d. Autorotative characteristics.

e. Latitude for student error.

f. Training endurance considerations.

g. Location of controls.

h. Susceptibility to ground resonance.

F. Coordination.

1. This report of test has been coordinated with the US Army Aviation School and the US Army Combat Developments Command Aviation Agency (USACDCAVNA). The USACDCAVNA expressed no staff interest. Comments from the Commandant, US Army Aviation School, are attached as appendix A, part III.

2. It is recognized that certain inconsistencies exist among the reports submitted by other agencies to this Board. These agencies tested each helicopter from a different viewpoint which accounts for many of these inconsistencies. As each of these reports has been submitted by each agency to its higher headquarters, and because of the short time allotted for revision of the overall report, many of these inconsistencies have not been resolved.

G. Findings.

1. None of the helicopters and associated proposals evaluated met completely all requirements contained in the Model Specification and Statement of Requirement.

2. Each helicopter and associated proposal evaluated were found to have deficiencies and shortcomings which adversely affected the suitability of its overall configuration.

3. The PH-4, PH-5, PH-6, and PH-7 met the USAPHS training mission requirement.

4. The PH-1 and PH-9 failed to meet the USAPHS training mission requirement as presently established.

H. Conclusions.

1. The PH-4, PH-5, PH-6, and PH-7, after correction of deficiencies and shortcomings listed in paragraph D, section one, units B, C, D, and E, part II of this report, will be suitable for Army use as primary helicopter trainers.

2. The PH-1 and PH-9, after correction of deficiencies and shortcomings listed in paragraph D, section one, units A and F, part II of this report, may be suitable for Army use as primary helicopter trainers. However, further evaluation would be necessary in the training environment of the USAPHS at Fort Wolters, Texas, before their suitability for the training mission requirement can be conclusively determined.

I. Recommendations. It is recommended that:

1. The PH-1, PH-4, PH-5, PH-6, PH-7, and PH-9, after correction of the deficiencies and shortcomings listed in this report, be considered qualified for Step Two of the procurement program.

2. If the PH-1 or PH-9 is successful, final determination of its suitability for the training mission requirement be made by the USAPHS after further evaluation at Fort Wolters, Texas.

3. Representatives of the test agencies (to include, but not be limited to, the US Army Primary Helicopter School, the US Army Aviation School, the US Army Board for Aviation Accident Research, the US Army Aeromedical Research Unit, and the US Army Aviation Test Board) be present when the unsuitable areas of the Model Specification noted in the helicopters and the manufacturers' revised technical proposals are discussed with the listed manufacturers.

Russell P. Bowers Col Armor
for A. J. RANKIN
Colonel, Armor
President

# ERRATA

## PART II - REPORT OF TEST

## USATECOM PROJECT NO. 4-3-1000-01-A

This errata sheet has been prepared in accordance with letter, AMSTE-BG, USATECOM, 31 December 1963, subject: "Report of Test, USATECOM Project No. 4-3-1000-01; Military Potential Test of Commercial 'Off-the-Shelf' Helicopters as Primary Helicopter Trainers." This letter requested changes of reports submitted by other agencies. The US Army Aeromedical Research Unit alone has authorized changes.

| Page No. | Para. No. | Change |
|---|---|---|
| 12, 68, 112, 156, 200, and 242. | C1a(3) | Change "specifications" to "requirement of the Statement of Requirement". |
| 13, 68, 113, 156, 201, and 243 | C1a(7) | Add new subparagraph: "Required inertia reels for shoulder harnesses were not provided or proposed." |
| 13, 69, 201, and 243 | C1a(8) | Amend to read: "...of this aircraft is not adequate for a primary trainer..." |
| 14 | C1c(6) | Amend sentence to read: "...with an average loss of altitude of 170 feet." |
| 16 | C1e(2) | Change "octane" to "performance number". |
| 16, 71, and 116 | C2b | Delete paragraph and renumber succeeding paragraphs accordingly. |
| 19, 74, 118, 162, 206, and 250 | 1.4 | Change "Yes" to "Not applicable". |

| Page No. | Para. No. | Change |
|---|---|---|
| 23 | 3.6 | In Remarks column, change "used" to "required," and "octane" to "performance number". |
| 24, 254 | 3.7 | In PH-1 Meets Spec. column, change "No" to "Yes". |
| 27, 257 | C3b | None. |
| 27 | C3b | In Remarks column, change "is susceptible" to "was susceptible". |
| 29 | D1b | Delete paragraph and renumber succeeding paragraphs. |
| 30 | D2c | Change "change-discharge" to "charge-discharge". |
| 39, 269 | 4 | *Amend to read:* "...illumination of this aircraft is not adequate for a primary trainer..." |
| 41 | 21 | None. |
| 47 | 2b(3) | None. |
| 58 | 3c | None. |
| 70 | C1c | Change lead-in to read: "The following were determined:" |
| 70, 158, and 245 | C1c(6) | Amend sentence to read: "...with an average loss of altitude of 150 feet." |
| 78, 210 | 3.7 | In Remarks column, add: "The cockpit and instrument panel illumination of this aircraft is not adequate for a primary trainer capable of performing night training missions. See paragraph A3, section two." |

| Page No. | Para. No. | Change |
|---|---|---|
| 81 | 3.10 | In Model Specification as Amended column, change "with" to "will". |
| 84, 216 | D2 | Add new subparagraph: Shortcoming: "The cockpit and instrument panel illumination is inadequate." Suggested Corrective Action: "Provide suitable illumination." |
| 88 | 4 | Amend to read: "...the aircraft will be adequate for a primary helicopter performing night missions." |
| 89 | 8 | Enter "No" in lieu of dashed line. |
| 89 | 9 | Enter "No (Note paragraph 3c.)" in lieu of dashed line. |
| 89 | 12 | Change "No" to "Yes." |
| 90 | 20 | Change dashes to "N/A." |
| 113, 156 | C1a(8) | Amend to read: "...illumination of this aircraft is adequate for a primary trainer capable of performing night training missions." |
| 115, 203 | C1c(6) | Amend to read: "...with an average loss of altitude of 150 feet." |
| 124 | 3.10 | Remarks should read: "Seat belts did not meet military specifications, and shoulder harness was not proposed." |
| 126 | Column Headings | Change "PH-1" to "PH-5". |
| 126 | C3b | Add the following immediately preceding Electrical: |

| Page No. | Para. No. | Change |
|---|---|---|
| | | Requirement: "Suitable seat belt and shoulder harnesses for both student pilot and instructor." |
| | | PH-5 Meets Requirement: "No" |
| | | Remarks: "Seat belts did not meet military specifications, and shoulder harnesses with inertia reels were not proposed." |
| 127 | D1b | In Deficiency column, change "provided" to "proposed." |
| 151, 152 | Not Applicable | None. |
| 159 | C2b | Delete "with inertia reels". |
| 166 | 3.6 | Change "No" to "Yes" and amend Remarks column to read: "Engine installed in test helicopter required 80/87 octane fuel; however, technical proposal specifies an engine which will operate satisfactorily on Standard Army fuels and lubricants." |
| 178 | 13 | No change. |
| 181 | 3c | Amend first sentence to read: "...carbon monoxide, 0.0005%, was found..." |
| 181 | 3d | Delete paragraph, and renumber succeeding paragraph. |
| 193 | 3a | No change. |
| 204 | C2c | Delete "with inertia reels". |
| 206 | 1.3 | Add the following to Remarks column: "However, an FAA |

| Page No. | Para. No. | Change |
|---|---|---|
| | | certification has been issued to the same model helicopter." |
| 215 | D1a | Amend both columns to read: "...belts and shoulder harnesses did not..." |
| | D1b | Delete paragraph, and renumber *succeeding paragraphs.* |
| 226 | 4 | Amend to read: "...cockpit and instrument panel illumination of this aircraft would be adequate for a primary trainer capable of performing night training missions." |
| 227, 228 | 8, 20 | Change dashes to "N/A." |
| 230 | 2f | No change. |
| 246 | C1e(2) | Change "octane" to "performance number)." |
| 246 | C1e(4) | Amend first sentence to read: "...of oil servicing (see paragraph 2.14.1, paragraph D, section two)." |
| 247 | C2c | Delete paragraph, and renumber succeeding paragraphs. |
| 254 | 3.6 | Change "No" to "Yes" and amend first sentence of Remarks column to read: "Engine oil required in the test helicopter was *not standard in* the US Army; however, standard Army engine oil can be used in this engine." |
| 259 | D1b | Delete paragraph, and renumber succeeding paragraphs. |
| 261 | D2f | Amend Shortcoming to read: "...to minor attitude changes." |

| Page No. | Para. No. | Change |
|---|---|---|
| 273 | 3d | No change. |
| 277<br>278 | Not Applicable | Reverse page numbers. |

## PART II - TEST DATA

## UNIT A - COMPANY A MODEL PH-1

## SECTION ONE

## USAAVNTBD REPORT

A. Description of Materiel.

1. The PH-1 is a single-engine, two-place, side-by-side, three-bladed single main rotor and tail rotor type helicopter. Power is supplied by an HO-360-B1A horizontally-mounted, four-cylinder, opposed type air-cooled non-supercharged engine which provides maximum rated power at sea level of 180 b.hp. at 2900 r.p.m. Engine power is transmitted to the rotors through drive shafts, a belt drive, and reduction gear boxes. The lower pulley of the belt drive is connected to the engine. The upper pulley is mounted on the main gear box pinion, the end of which is also splined to the tail-rotor drive shaft. The belt-drive assembly incorporates an idler pulley, controlled from the cockpit, which acts as a clutch for engaging and disengaging the engine from the rotor.

2. Flight controls consist of a cyclic stick, collective pitch stick, and antitorque control pedals. Cyclic trim controls (fore-and-aft and lateral) are of the adjustable bungee type. Adjustable friction devices are provided for the collective pitch and cyclic controls.

3. The main rotor is fully articulated and utilizes three all-metal rotor blades. A two-bladed antitorque tail rotor mounted on a delta hinge provides directional control.

4. The fuselage components are attached to the central framework of steel tubing. The seat, floor, and main rotor mast support structure form a detachable unit, and are fabricated from sheet metal. A tail boom is fabricated from a single piece of aluminum tubing. A transparent plastic canopy, tinted overhead, is provided. A skid-type landing gear incorporates oleo-type struts between cross tubes and skids. Ground-handling wheels are removable and are positioned at the front of the skids for flight.

5. General dimensions of the helicopter submitted for test are listed below:

| | | |
|---|---|---|
| a. | Overall height | 8 feet 2.6 inches |
| b. | Overall length (main rotor tip to tail rotor tip) | 28 feet 3.0 inches |
| c. | Rotor diameter | 25 feet |
| d. | Fuselage width | 4 feet 3.0 inches |
| e. | Skid gear tread (maximum) | 6 feet 6.5 inches |

B. Scope of Test. The test was conducted in the vicinity of Fort Rucker, Alabama, by USAAVNTBD project officers and USAPHS instructor personnel. The tests consisted of three phases: a 60-flying-hour test, a study of the manufacturer's technical proposals which described changes to configure the test helicopter to meet the stated requirements, and a comparison of the helicopter with the Model Specification and Statement of Requirement. In addition, the US Army Board for Aviation Accident Research (USABAAR) evaluated the aviation safety aspect; the US Army Aviation Human Research Unit (USAAHUMRU) evaluated the human factors aspect; and the US Army Aeromedical Research Unit (USAARU) evaluated noise level, internal lighting, and heating and ventilation.

C. Tests.

1. Evaluation of Physical and Flight Characteristics, Performance, Mission Suitability, and Maintenance.

a. Physical Characteristics.

(1) Basic and Operating Weights. The helicopter was weighed as delivered with oil and trapped (unusable) fuel. To this weight (982 pounds), the weight of electronic and auxiliary equipment required for Army use (95 pounds) was added, and the weight of currently-installed equipment not required for Army use (28 pounds) was subtracted, resulting in a total estimated basic weight of 1049 pounds. The estimated mission operating weight was then computed by adding to the estimated basic weight the weight of fuel (150 pounds) and 400 pounds (instructor and student). Details follow:

| | | |
|---|---|---|
| EMPTY WEIGHT as weighed (less ground-handling wheels) | | 982 lb. |
| Weight of required equipment to be added: | | |
| Shoulder harness and inertia reel (2 ea.) | 6 lb. | |
| First-aid kit and fire extinguisher | 10 lb. | |
| AN/ARC-45 (UHF) | 27 lb. | |
| C-1611 interphone (2 ea.) | 4 lb. | |
| Attitude indicator (proposed) | 3 lb. | |
| MA-7 battery | 34 lb. | |
| Heater (proposed) | 11 lb. | |
| TOTAL ADDED | 95 lb. | 95 lb. |
| | | 1077 lb. |
| Weight of installed equipment to be removed: | | |
| Commercial radio | 7 lb. | |
| Twelve-volt battery | 21 lb. | |
| TOTAL SUBTRACTED | 28 lb. | -28 lb. |
| TOTAL BASIC WEIGHT (estimated) | | 1049 lb. |
| Fuel | | 150 lb. |
| Instructor and student | | 400 lb. |
| MISSION OPERATING WEIGHT (estimated) | | 1599 lb. |
| MAXIMUM CERTIFICATED GROSS WEIGHT | | 1600 lb. |

(2) Center-of-Gravity Travel. Control travel was sufficient to provide control at the extremes of allowable center-of-gravity

(CG) position at maximum certificated and normal operating gross weights. The addition, removal, or relocation of ballast or aircraft components was not necessary for the helicopter to remain within CG limits when changes were made in loading of the helicopter with respect to fuel, instructor, and student. No determination was made of the helicopter's CG travel when flown from the left seat as the rotor engage lever could not be operated from the left seat.

(3) Ground Clearance. Ground clearance was sufficient for operation in unimproved areas; however, engine exhaust stacks did present a fire hazard in tall grass. At normal operating r.p.m. ground-to-main-rotor clearance was satisfactory with cyclic stick centered but did not meet specifications when cyclic was fully displaced.

(4) Ground-Handling Characteristics. Ground-handling characteristics of the helicopter, with removable wheels provided, were satisfactory.

(5) Suitability for Hoisting, Jacking, and Mooring. The helicopter was equipped with suitable hoisting and jacking hard points and had suitable locations on the structure for attachment of mooring lines.

(6) Suitability of External Power Receptacle. The helicopter was equipped with an external power receptacle which was compatible with Army APU's.

(7) Adequacy of Cockpit Configuration and Arrangement. The cockpit configuration and arrangement of the test helicopter were evaluated except for those items changed in the manufacturer's technical proposal. The cockpit configuration and arrangement were satisfactory except for the following:

(a) The rotor-engage lever was accessible from the student pilot station (right seat) only and could not be reached or operated from the instructor pilot station (left seat).

(b) The engine can be started with the rotor engage lever in the "engage" position. This will result in dephasing of the dampers and possible structural damage to the main rotor system.

(c) The location and type of cyclic trim controls (fore-and-aft and lateral) were unsatisfactory. Trim controls were

accessible from the student position only and required release of the collective pitch control to operate.

(d) The location of cyclic friction controls (fore-and-aft and lateral) was unsatisfactory. Friction controls were accessible from the student position only but required release of the collective pitch control to operate.

(e) Installed seat belts did not meet Military Specifications.

(f) The landing light ON indicator was located next to the oil temperature and pressure warning lights and all were equipped with red cat-eye lenses.

(g) Oil temperature and pressure warning light and anti-glare shield obstructed the view of warning-light placards.

(h) Doors were not jettisonable for emergency exit.

(8) Suitability of Internal Lighting. The USAARU evaluation (paragraph A, section two) is summarized as follows: "The cockpit and instrument panel illumination of this aircraft did not meet the Military Standards for a primary trainer capable of performing night training mission."

(9) Suitability of External Lighting. The position lights, located on the forward cross tubes of the landing gear skids were satisfactory. Reflections of the position lights from the polished aluminum main-rotor blades were distracting.

(10) Durability and Reliability. Durability and reliability could not be determined within the relatively short test time specified.

(11) Transportability. The helicopter is capable of being transported by C-123/C-130 type aircraft and by surface transport.

(12) Noise Level. The USAARU evaluation (paragraph A, section two) is summarized as follows: "Internal and external sound pressure levels met the Statement of Requirement. However, numerous internal measurements exceed the Military Specifications for acoustical noise levels in Army aircraft."

b. Flight Characteristics. The helicopter was flown at gross weights up to the maximum certificated (1600 pounds). The following was determined:

(1) Stability. The stability of the helicopter was unsatisfactory for primary student training (see paragraph d below).

(2) Controllability. Controllability was unsatisfactory for primary student training (see paragraph d below).

c. Performance. The helicopter was flown at FAA-certificated gross weight of 1600 pounds to determine whether it met the performance criteria stated in the Model Specification (see paragraph 3a). The following was determined:

(1) The helicopter was capable of cruising at 65 knots true airspeed (TAS) at sea level.

(2) Endurance at 65 knots (TAS) was 2.6 hours at a density altitude of 3200 feet.

(3) Hover-out-of-ground effect could be accomplished at a density altitude of 4400 feet which is equivalent to a pressure altitude of 1000 feet with an ambient temperature of 110°F.

(4) The rate of climb under ICAO sea level standard day conditions at 45 knots (TAS) was 1500 feet per minute.

(5) The autorotational performance was determined at 4400 feet density altitude (1000 feet pressure altitude, 110°F.) and at a true airspeed of 45 knots for maximum gross weight. Tested under these conditions, the rate of descent was 1800 feet per minute.

(6) In autorotation under those conditions (paragraph (5) above), the helicopter regained normal rotor r.p.m. following a decay of rotor r.p.m. to the lower operating limit with an average of a 170-foot loss of altitude.

(7) The helicopter was capable of landing cross slope on 15-degree slopes.

(8) Rapid engagement of the clutch or power surges could dephase the blade dampers, producing a condition conducive to ground resonance.

d. Mission Suitability. This portion of the test was conducted by USAPHS. Their report (paragraph B, section two) is summarized as follows:

"The PH-1 Helicopter is unsuitable for the training mission because of the following characteristics:

"a. Sensitivity of the directional controls.

"b. Lack of sufficient pedal control for recovery from student errors and inadvertent unusual attitudes.

"c. The rate of movement to the point from which a safe recovery from unusual attitudes becomes difficult is exceedingly fast thereby allowing insufficient latitude for instructor pilot corrections. The student is afforded little opportunity to correct his own mistakes.

"d. The problems of directional control, insufficient pedal control, and latitude for student error are magnified by a crosswind condition.

"e. The rapid rotor decay after initial pitch application with subsequent reduction in directional control during touchdown autorotations leaves little margin for a safe recovery from student error.

"f. The techniques required for the autorotational touchdown are unacceptably critical for primary student training.

"g. The rapid rotor decay, yawing to the left of approximately forty-five degrees, and attitude changes of the aircraft at power cut for a simulated forced landing leave no margin for student error. These require the instructor to advise the student in advance of the maneuver and heavily ride the controls, thus leading the student into the autorotational descent.

"h. Any rapid application of throttle to join the needles or to apply power during ground operations dephased the blade dampers inducing a condition conducive to ground resonance.

"i. Control trims and friction locks are available only to the student pilot. Students mistakenly applied friction locks when asked for cyclic trim."

e. Maintenance.

(1) During the evaluation, the helicopter was maintained by the manufacturer's representative with military personnel provided for servicing, general assistance, and maintenance of records. The helicopter required only organizational maintenance. The general simplicity of the aircraft resulted in relatively low maintenance man-hours per flight hours.

(2) Engine operation was trouble free when operated on standard Army aviation fuel (115/145 octane).

(3) The engine was not operated on standard Army aviation lubricants during the test. High-detergent oil was furnished by the manufacturer.

(4) With the exception of oil servicing, the helicopter was easy to service and maintain. All major components are readily accessible; however, no replacements were required during the evaluation.

(5) The blue main-rotor-blade drag damper was repeatedly dephased by power surges. Rephasing required readjustment with special tools prior to continuing flight.

(6) Tools and ground-support equipment normally found at the organizational level were adequate for organizational maintenance with the exception of the special tools required for rephasing. Special tools are required for higher echelons of maintenance.

2. Evaluation of Manufacturer's Technical Proposal. The manufacturer's technical proposal to configure the test helicopter to meet Model Specification was reviewed and the following was determined:

a. The landing light (ground adjustable) was satisfactory.

b. Required inertia reels for shoulder harnesses were not proposed.

c. Electronic configuration was found to be satisfactory with the exception of the location of the C-1611 interphone control which was not readily accessible from either the instructor or the student crew station.

d. Floor-mounted and cyclic-control-mounted radio-interphone keying switches were provided for both student and instructor pilot stations.

e. The proposal for a 24-volt electrical system was satisfactory. The alternate proposal for a 12-volt electrical system was unsatisfactory.

f. A muff-type heater was proposed.

g. An attitude indicator was proposed.

h. The USABAAR evaluation (paragraph C, section two) is summarized as follows:

"The evaluation considered the categories of Operation Safety, Maintenance Safety, and Crashworthiness. USABAAR considers this aircraft to be unacceptable as a primary helicopter trainer because of the high level of skill required to successfully perform an autorotation."

i. The USAAHUMRU evaluation (paragraph D, section two) is summarized as follows:

"The design philosophy of the PH-1 was in large part guided by human factors considerations related to the primary helicopter training mission. As a result, the aircraft was found to be highly satisfactory from the human factors standpoint. Design decisions in large part appear to have been resolved in favor of the crew, maintenance personnel, or freedom from maintenance, rather than maximization of performance parameters.

"The major deficiencies noted were poor sideward visibility for tall personnel, an unsatisfactory location for the C-1611 Intercommunication Set Control, and failure to specify the manner of installation of shoulder harnesses. In its proposed location, the C-1611 control would be dangerous due to its sharp edges, difficulty to use, and difficulty to see. (Specification of this relatively large control is regarded as unrealistic for this compact helicopter, and it is recommended that any Army purchase specify that the contractor provide the applicable functions of these C-1611 controls at the location of the presently installed Interphone-Transmit switch, which is quite satisfactory.)

"Strong points were: good visibility, except as noted above; and, good design from the standpoint of inspection and maintainability."

3. Comparison with Model Specification and Statement of Requirement. In determining whether the PH-1 met the requirements of the Model Specification and Statement of Requirement, the characteristics of the helicopter as tested and an evaluation of the manufacturer's technical proposal were considered.

a. Comparison with Model Specification as Amended.

| Mod. Spec. Para. No. | Model Specification as Amended | PH-1 Meets Spec. | Remarks |
|---|---|---|---|
| 1. | SCOPE. | | |
| 1.1 | Scope. This detail specification covers the essential requirements for the design of a single engine primary helicopter trainer capable of performing the mission specified in 1.2. | | |
| 1.1.1 | Designation and General Description. | | |
| | Army Model Designation - Primary Helicopter Trainer (Army Model Number not yet assigned). | | |
| | Number of Crew - 1 Pilot | Yes | |
| | Number of Passengers - 1 Student | Yes | |
| | Crew and Passenger Seating Arrangement - Side by Side | Yes | |

| Mod. Spec. Para. No. | Model Specification as Amended | PH-1 Meets Spec. | Remarks |
|---|---|---|---|
| | Flight Controls - Dual | Yes | |
| | Type of Engine - Reciprocating | Yes | |
| | Main Rotor System - Single | Yes | |
| 1.2 | Mission. The primary Army mission for which this helicopter will be employed is training of military pilots in the basic operation and performance of a helicopter. Training will be accomplished under conditions to which Visual Flight Rules apply. | No | See paragraph B, section two. |
| 1.3 | Federal Aviation Agency Certification. The helicopter will have a Part 6 standard airworthiness certificate issued by the Federal Aviation Agency. | Yes | |
| 1.4 | Performance Information. Those items of performance stated as requirements herein which are not included in the FAA approved flight manual are subject to verification by the U. S. Army. | Yes | |
| 2. | APPLICABLE DOCUMENTS. | | |
| 2.1 | The documents applicable to this specification are | Yes | |

| Mod. Spec. Para. No. | Model Specification as Amended | PH-1 Meets Spec. | Remarks |
|---|---|---|---|
| | those necessary to fulfill the requirements of paragraph 1.3, Federal Aviation Agency Certification. | | |
| 3. | REQUIREMENTS. | | |
| 3.1 | Basic Weight. The basic weight of the helicopter will include all required installed equipment including the items of Paragraphs 3.7, 3.8.1.1, 3.8.1.2 and the Electronic Equipment as stated in Table E, Appendix I. | Yes | |
| 3.2 | Center of Gravity Travel. Addition, removal or relocation of ballast or aircraft components will not be necessary in order to maintain the CG within CG limits due to changes in loading of the helicopter with respect to fuel, pilot and student. | Yes | |
| 3.3 | Useful Load. The useful load of the helicopter will be sufficient for 400 lbs. in addition to the fuel and oil necessary to accomplish the 2 1/2 hour endurance mission specified in paragraph 3.4.1. | Yes | |
| 3.4 | Required Performance. | | |

| Mod. Spec. Para. No. | Model Specification as Amended | PH-1 Meets Spec. | Remarks |
|---|---|---|---|
| 3.4.1 | ICAO Sea Level Standard Day Performance (at certificated gross weight). | | |
| | Cruise Speed (Minimum) - 65 knots | Yes | |
| | Endurance (Minimum) - 2 1/2 hours at 65 knots cruise speed | Yes | |
| | Rate of Climb (Minimum) - 1000 ft. per minute | Yes | |
| 3.4.2 | Hovering Performance Requirement. At certificated gross weight the aircraft shall hover out of ground effect at 1000 ft. at 110°F. | Yes | |
| 3.4.3 | Autorotation Characteristics (at certificated gross weight). | | |
| 3.4.3.1 | Normal Autorotation Speed. The manufacturer will designate a speed for normal autorotation not to exceed 45 knots. | Yes | |
| 3.4.3.2. | Rate of Descent. At the speed designated in 3.4.3.1 the helicopter will not exceed a stabilized autorotation rate of descent of 2200 feet per minute under conditions of 1000 ft. altitude and 110°F. | Yes | |

| Mod. Spec. Para. No. | Model Specification as Amended | PH-1 Meets Spec. | Remarks |
|---|---|---|---|
| 3.4.3.3 | Rotor R.P.M. Decay. In autorotation at the speed in 3.4.3.1 and conditions of 1000 ft. and 110°F., if rotor R.P.M. decays to the lower rotor R.P.M. limit, the helicopter will be capable of regaining normal operating R.P.M. (as specified by the manufacturer) and with an altitude loss not to exceed 200 feet. | Yes | |
| 3.5 | Aircraft Structure. | | |
| 3.5.1 | Landing Gear. | | |
| 3.5.1.1 | Type Landing Gear. Skid type landing gear which will permit running take-offs and landings. | Yes | |
| 3.5.1.2 | Slope Landings. The landing gear will permit cross slope landings on slopes of 15°. | Yes | |
| 3.5.1.3 | Ground Handling. Ground handling wheels are required. Weight of the ground handling wheels will not be included in the weight empty if they are detachable. | Yes | |
| 3.5.1.4 | Hoisting, Jacking, and Mooring. Provisions will be made for hoisting, jacking, and mooring. | Yes | |

| Mod. Spec. Para. No. | Model Specification as Amended | PH-1 Meets Spec. | Remarks |
|---|---|---|---|
| 3.5.2 | Main Rotor Blades. | | |
| 3.5.2.1 | Blade Interchangeability. The main rotor blades will be individually interchangeable. | Yes | |
| 3.5.3 | Control Pedals. Both sets of directional control pedals of the aircraft will be adjustable. | Yes | |
| 3.5.4 | Operating Environment. | | |
| 3.5.4.1 | Aircraft Operation. The aircraft will be capable of operating in temperatures from 0°F. to +100°F. | Undetermined | Temperatures during tests ranged from 75°F. to 95°F. |
| 3.5.4.2 | Cabin Heating. The aircraft will have a heating system which provides a minimum of 50°F. cabin temperature with 0°F. outside air temperature. This condition need only be satisfied with the engine operating. | Undetermined | Muff-type heating system proposed. Due to temperature ranges, this test could not be conducted. |
| 3.6 | Fuel and Lubricants. The engine will operate on such fuel and lubricants which are now established as standard by the U.S. Army (Ref: MIL-G-5572C dated 12 Jul 60 & MIL-L-22851 dated 30 Jun 61 & MIL-L-6082C dated 18 May 61). | No | Engine oil used was not standard in the Army. Engine operated satisfactorily on 115/145 octane fuel. |

| Mod. Spec. Para. No. | Model Specification as Amended | PH-1 Meets Spec. | Remarks |
|---|---|---|---|
| 3.7 | Instruments and Navigational Equipment. Flight instruments and lights for day and night VFR conditions shall be furnished and installed by the contractor. | No | Instrument lighting was unsatisfactory. See paragraph A, section two. |
| | An attitude indicator shall be provided as part of the basic aircraft instrumentation. | Yes | |
| 3.8 | Electrical. | | |
| 3.8.1 | Lighting. | | |
| 3.8.1.1 | Anti-Collision Light. The aircraft will have an anti-collision light. The light will be located to prevent reflection into the cockpit. | Yes | |
| 3.8.1.2 | Landing Light(s). The aircraft will be equipped with landing light(s) which will be adjustable. | Yes | |
| | The landing light switch will be located on the pilot's cyclic or collective control. | Yes | |
| 3.8.2 | Power Receptacle. The aircraft will be equipped with an external power receptable of an AN or AMS standard design. | Yes | |
| 3.8.3 | Switches and Auxiliary Controls. All switches and | No | Rotor engage lever, |

| Mod. Spec. Para. No. | Model Specification as Amended | PH-1 Meets Spec. | Remarks |
|---|---|---|---|
| | auxiliary controls necessary for flight and navigation will be accessible and within reach of the student pilot and the instructor pilot. | | cyclic friction controls, and cyclic trim controls were not available to the IP. Cyclic friction controls and cyclic trim controls were difficult for the student to reach. The C-1611 control head was difficult to see and read. |
| | Switches and controls shall be operable in flight by personnel wearing winter flight clothing. | No | |
| | Accessible floor mounted and cyclic control mounted radio-interphone switches will be provided for both student pilot and instructor. | Yes | |
| 3.9 | Electronic Equipment. The aircraft will be equipped with the electronic equipment as indicated in Appendix I. | Yes | |
| 3.10 | Safety Equipment. Seat belt and shoulder harness will be furnished for all occupants. | Yes | Seat belts and shoulder harnesses did not meet Military Specification. |

| Mod. Spec. Para. No. | Model Specification as Amended | PH-1 Meets Spec. | Remarks |
|---|---|---|---|
| | Appendix I | | |
| | Communiction | | |
| | UHF - AN/ARC-45, 1 ea. | Yes | GFE |
| | ICS - C-1611, 2 ea. | Yes | GFE |
| | Miscellaneous | | |
| | Antenna - AT-450/ARC, 1 ea. | Yes | GFE |
| | Battery - Sonotone MA-7, 1 ea. | Yes | |
| | *Inverter (If required either* inverter listed will be a suitable substitute for standard equipment) - Leland MIL-E-93-200 or Bendix 328-172-1, 1 ea. | Yes | Self-contained inverter was proposed with the attitude indicator. |

b. Comparison with Statement of Requirement. A comparison with the Statement of Requirement (reference 4) excluding those requirements covered by the Model Specification follows:

| Requirement | PH-1 Meets Requirement | Remarks |
|---|---|---|
| Size | | |
| It is desired that the external dimensions of the helicopter, less rotor, not exceed 8 feet in height, 23 feet in length, and 7 feet in width. | Yes | |
| With full cyclic movement, the rotor blade tip clearance | No | With cyclic centered and normal rotor r.p.m., |

| Requirement | PH-1 Meets Requirement | Remarks |
|---|---|---|
| above the ground level should not be less than 6 feet with rotors turning. | | ground-to-main-rotor clearance was satisfactory. |
| A minimum rotor diameter consistent with good autorotative characteristics is desired. | Yes | |
| **Structure and Design** | | |
| The following will be required: | | |
| Main rotor blades which are interchangeable, without retracking are desirable. | Yes | |
| If more than two main rotor blades, provisions should be provided for simple expeditious folding and unfolding. | Yes | |
| It shall be free from ground resonance. | No | Fully-articulated rotor head is susceptible to ground resonance. |
| Suitable seat belt and shoulder harness for both student pilot and instructor. | No | Seat belts and shoulder harnesses did not meet Military Specification and inertia reels were not proposed. |
| **Electrical** | | |
| The following are required: Lighting; adequate position, cockpit, anti-collision, and landing lights for night flight. Position and anti-collision lights to be positioned to | No | Position light caused distracting reflections on main rotor blade. Cockpit lighting not satisfactory. Landing light specified in |

| Requirement | PH-1 Meets Requirement | Remarks |
|---|---|---|
| prevent reflection into the cockpit; landing light to be adjustable. | | technical proposal will be ground adjustable. |
| **Durability and Reliability** | | |
| Engine and dynamic components should not be materially affected by dust, sand, moisture, etc., encountered in operation from unprepared areas. | Undetermined | |
| **Noise Level** | | |
| The lowest possible noise level is desired without use of a complex or elaborate muffler system or extension or heavy insulation. | Yes | Exceeded MIL-A-8806 in all areas (reference paragraph A, section two); however, a standard muffler was available. |
| **Personnel Considerations** | | |
| No new personnel skills will be required. | Yes | Due to similarity of the helicopter to other helicopters in the Army inventory, no new skills will be required. |
| **Training Considerations** | | |
| No new training requirements will be generated. | Undetermined | Further evaluation in an actual training environment is required. |
| No supporting training devices other than those on hand at the US Army training base are required. | Yes | |

D. Deficiencies and Shortcomings.

1. The following deficiencies were noted during conduct of the test:

| Deficiency | Suggested Corrective Action |
|---|---|
| a. Directional control was unsatisfactory. | Decrease sensitivity of directional control. |
| b. Throttle and pitch correlation was unsatisfactory. | Improve throttle and pitch correlation. |
| c. Spring-loaded throttle with no override position was unsatisfactory. | Provide override position. |
| d. Low inertia rotor system was unsatisfactory. | Increase rotor inertia. |
| e. Aircraft became unstable with inadvertent application of left pedal in autorotation. | Improve stability. |
| f. Crashworthiness was unsatisfactory. | Reference paragraph C, section two. |
| g. The engine could be started with the rotor-engage lever in the "engage" position. | Provide a system to prevent starter engagement with the rotor-engage lever in the "engage" position. |
| h. Rotor-engage lever was accessible from the student pilot station only and could not be operated from the instructor pilot station. | Relocate rotor-engage lever. |
| i. The location and proposed type of trim controls were unsatisfactory. | Provide suitable trim controls. |
| j. The location of cyclic friction controls was unsatisfactory. | Relocate cyclic friction controls. |
| k. Doors were not jettisonable. | Provide jettisonable doors. |

| Deficiency | Suggested Corrective Action |
|---|---|
| l. Cockpit and instrument illumination did not meet military standards. | Provide illumination which meets military standards. |
| m. Proposed location of C-1611 interphone controls was unsatisfactory. | Relocate C-1611 interphone controls. |
| n. Inertia reels were not provided on the test helicopter or included in the technical proposal. | Provide inertia reels. |
| o. Seat belts did not meet military specification. | Install seat belts and shoulder harnesses which meet military specification. |
| p. Helicopter was susceptible to ground resonance. | Unknown. |

2. The following shortcomings were noted during conduct of the test:

| Shortcoming | Suggested Corrective Action |
|---|---|
| a. No provisions were made for quick-disconnect of the battery. | Provide for quick-disconnect of battery. |
| b. Oil temperature and pressure warning light placards were obstructed by the landing light caution indicator glare shield. | Relocate the landing light caution indicator glare shield. |
| c. An ammeter measuring change-discharge rates of the battery was provided in lieu of a load meter measuring the load on the generator. | Install load meter. |
| d. Engine exhaust presented a fire hazard in tall grass. | Provide adequate shielding. |
| e. Engine instruments group was unsatisfactory. | Provide satisfactory instruments group. |

| Shortcoming | Suggested Corrective Action |
| --- | --- |
| f. Landing light on indicator (cat-eye) light had red lens and was located in close proximity to oil pressure warning light. | Change red color lens to amber color and relocate indicator. |
| g. Airspeed indicator was sensitive to minor attitude changes. | Provide satisfactory airspeed indicator. |
| h. Pitch change push-pull rods were susceptible to damage if used as hand holds. | Placard pitch change push-pull rods. |
| i. Magnetic chip detectors were not installed. | Install magnetic chip detectors of the continuous read-out type in the transmission and engine oil sumps. |

## SECTION TWO

### Reports from Other Agencies on the PH-1

PARAGRAPH A

Aviation Field Operations Division
U.S. ARMY AEROMEDICAL RESEARCH UNIT
Fort Rucker, Alabama 36362

USAARU-FO 29 July 1963

## NOISE EVALUATION OF THE PH-1

1. Methods and Equipment.

a. Due to the number of aircraft to be tested and the short time available, the noise analysis was limited to the following:

(1) "A" - 24-55 db: sound level for speech interference.

(2) "B" - 55-85 db: sound level for noise survey.

(3) "C" - 85-140 db: sound pressure level--over-all frequency response.

b. A General Radio, Sound-Level-Meter, type 1551-C, was used for the noise measurements.

c. The test area, located at County Line Strip, is a pre-marked compass rose with a 50 foot radius.

2. Results. (See Annex A)

3. Discussion.

| | Door On | Doors Off | MIL-A-8806 |
|---|---|---|---|
| Normal cruise | 109 | 112 | 106 |
| Maximum cruise | 112 | 115 | 113 |

a. Operation of this helicopter at normal cruise with the cockpit doors on or off produces internal sound pressure levels in excess of Table I MIL-A-8806.

b. Operation of this helicopter at maximum cruise with the doors off produces internal sound pressure levels in excess of Table IV MIL-A-8806.

c. There are no military specifications for external noise. Raw data is included for comparison purposes only.

4. Summary. Improvements should be made to reduce noise levels to meet military specifications (MIL-A-8806).

1 Incl
as

/s/ William C. Thrasher
/t/ WILLIAM C. THRASHER
2/Lt., MSC
Ass't Chief, Avn Fld Opns Div

NOISE LEVEL MEASUREMENTS-OCTAVE BAND ANALYSIS

DATA COLLECTION SHEET

Analyzed by Lt. W. C. Thrasher
S/Sgt Lonnie Parsons

Date 14 June 1963

PH-1

| DOORS-ON | A | B | C | Center | Student | Indic Air Speed | Mani-fold | RPM | Radius |
|---|---|---|---|---|---|---|---|---|---|
| Ground idle | 96 | 101 | 105 | | 1 | - | 13" | 2000 | |
| Ground high power | 100 | 106 | 117 | | 1 | - | 15" | 2900 | |
| Hover | 101 | 109 | 113 | | 1 | - | 25" | 2900 | |
| Normal cruise | 99 | 105 | 109 | | 1 | 70 | 22" | 2700 | |
| Maximum cruise | 102 | 107 | 112 | | 1 | 80 | 25" | 2900 | |
| DOORS-OFF | | | | | | | | | |
| Ground idle | 95 | 104 | 111 | | 1 | - | 13" | 2000 | |
| Ground high power | 101 | 108 | 113 | | 1 | - | 15" | 2900 | |
| Hover | 103 | 108 | 113 | | 1 | - | 25" | 2900 | |
| Normal cruise | 99 | 106 | 112 | | 1 | 70 | 22" | 2700 | |
| Maximum cruise | 102 | 110 | 115 | | 1 | 80 | 25" | 2900 | |
| EXT HIGH POWER | | | | | | | 15" | 2900 | |
| (LEFT) | | | | (RIGHT) | | | | | |
| 0 | 89 | 94 | 97 | 0 | 88 | 93 | 96 | | 50' |
| 30 | 88 | 93 | 96 | 30 | 86 | 91 | 94 | | 50' |
| 60 | 90 | 94 | 97 | 60 | 87 | 92 | 95 | | 50' |
| 90 | 92 | 95 | 97 | 90 | 89 | 92 | 96 | | 50' |
| 120 | 93 | 97 | 99 | 120 | 92 | 95 | 99 | | 50' |
| 150 | 95 | 99 | 101 | 150 | 95 | 99 | 101 | | 50' |
| 180 | 95 | 102 | 105 | 180 | 95 | 101 | 104 | | 50' |
| HOVER | | | | | | | 25" | 2900 | |
| 0 | 90 | 95 | 98 | 0 | 90 | 96 | 99 | | 50' |
| 30 | 93 | 96 | 100 | 30 | 92 | 93 | 99 | | 50' |
| 60 | 95 | 96 | 99 | 60 | 95 | 95 | 99 | | 50' |
| 90 | 98 | 99 | 101 | 90 | 96 | 98 | 100 | | 50' |
| 120 | 101 | 103 | 105 | 120 | 99 | 101 | 102 | | 50' |
| 150 | 104 | 108 | 109 | 150 | 106 | 107 | 109 | | 50' |
| 180 | 104 | 108 | 110 | 180 | 103 | 105 | 110 | | 50' |

Annex A

Aviation Field Operations Division
U. S. ARMY AEROMEDICAL RESEARCH UNIT
Fort Rucker, Alabama

USAARU-FO

25 June 1963

# LIGHT EVALUATION OF THE PH-1

1. Methods and Equipment.

a. The evaluation consisted of in-flight analysis of the aircraft's lighting system under night conditions. Criteria for this evaluation were derived from U. S. Navy Specifications governing cockpit and instrument panel illumination modified to meet Army requirements.

b. A standard Norwood photo-electric meter was used to measure over-all cockpit illumination from the auxiliary hand light or map light.

2. Results. (See Annex A)

3. Discussion.

a. Luminous paint and ultraviolet light used to illuminate instrument dials and gauges afford adequate light intensity but impair visual acuity. The extreme contrast between the black, light absorbing background of the dials and the luminous markings can cause discomfort and distraction to an inexperienced aviator.

b. When the instrument panel lights were adjusted to adequately illuminate the instruments, a great amount of light was reflected from the bubble into the pilot's eyes. With the instrument panel lights turned off, a complete panel of luminous dials and gauges was reflected in the bubble.

c. An auxiliary light or map light should be placed in the cockpit to aid in navigation and to furnish light in case of electrical failure of the instrument panel lighting circuit.

d. The running lights mounted on the bubble above each door should be moved to reduce reflection in the cockpit.

e. The landing light should be mounted on an adjustable bracket allowing the pilot to adjust the light to his angle of approach.

4. Summary. At present the cockpit and instrument panel illumination of this aircraft does not meet the military standards for a primary trainer capable of performing night training missions.

1 Incl
as

/s/ William C. Thrasher
/t/ WILLIAM C. THRASHER
2/Lt., MSC
Ass't Chief, Avn Fld Opns Div

Aviation Field Operations Division
U. S. ARMY AEROMEDICAL RESEARCH UNIT
Fort Rucker, Alabama

COCKPIT LIGHT STUDY
PH-1

1. Are all instruments adequately illuminated? No (Note para 3a).

2. Are they illuminated uniformly? Yes Is there sufficient intensity? Yes

3. Is illumination controllable to very low intensities? Yes (Rheostat)

4. Are markings of instruments readable? No

5. Are all controls, instructions, and nameplates adequately illuminated? No

6. Are they illuminated uniformly? No Is there sufficient intensity? No

7. Is illumination controllable to very low intensities? No (Note para 3b).

8. Are markings on controls, instructions and nameplates readable? No

9. Is the intensity of lighting for some instruments and controls controlled separately? N/A

10. Is an auxiliary light provided? No Is the light standard red? N/A

11. Is the power source independent of normal lighting circuit? N/A

12. Are there any sources of light which give other than standard red light? Yes

13. Are there any reflections in the windshield, windows, canopy or other reflecting surfaces which interfere with visibility inside or outside the cockpit? Yes (Note para 3b).

ANNEX A

14. Is there light leakage into the cockpit from other compartments? N/A

15. Are spare lamps provided in sufficient quantity and easily accessible? N/A

16. Are all instruments, instructions, nameplates, and control markings readable in daylight? Yes

17. Are warning and caution lights adequate for night operations? Yes

18. Are warning and caution lights of sufficient intensity for daylight use? Yes

19. Are warning and caution lights on the main dimming circuit? No

20. Is lighting provided in accordance with the aircraft detail specification? N/A

21. Is the auxiliary light adequate for reading? No

22. Does the light cause glare to cockpit? N/A

23. Is there adequate general illumination for the compartment? No (Note para 3c).

24. Do any of the exterior lights provide glare in the cockpit? Yes (Note para 3d, e).

25. Is exterior lighting provided in accordance with FAA? Yes

Aviation Field Operations Division
U. S. ARMY AEROMEDICAL RESEARCH UNIT
Fort Rucker, Alabama

USAARU-FO

25 June 1963

REPORT ON PH-1

1. Method of Testing.

a. The heating and ventilation evaluation of the PH-1 consisted of comparisons of outside air temperature and cockpit air temperature with the aircraft under all operating conditions. In conjunction with these checks, a carbon monoxide test was also made.

b. Equipment consisted of:

(1) Weston Aneroid Thermometer, Model 2291.

(2) Mine Safety Appliance Company Carbon Monoxide Tester, Category No. DS-47133.

2. Results. (See Annex A)

3. Discussion.

a. Although reasonably high temperatures were encountered on the aircraft with doors on, windows closed and vents closed (see Annex A), it is felt that this aircraft will rarely be operated under those conditions with existing outside temperatures in the 90°F range.

b. The recommended maximum temperatures for clothed men not especially acclimatized are as follows:

(1) Resting in still air - 88°F.

(2) Resting, with some air movement (170 FPM air velocity) - 93°F.

(3) Moderate work, still air - 78°F.

Reference: Patty, Frank A., Industrial Hygiene & Toxicology (2d ed., Vol. 1; New York: Interscience Publishers Inc., 1958).

c. Comparing recommended working temperatures (see above) with temperatures found in aircraft (see Annex A), a mean working temperature of 90° F was derived. This is felt to be within limits.

d. A small percentage of carbon monoxide (.01) was found in the aircraft with the doors on, windows closed, vents closed, and the aircraft on the ground at operating RPM. This amount is not felt to be significant and rarely will aircraft be operated on the ground with doors on, windows closed, and vents closed.

e. A heater was not present on this aircraft.

1 Incl
as

/s/ J. C. Rothwell
/t/ J. C. ROTHWELL
Captain, MSC
Ass't Chief, Avn Fld Opns Div

PH-1

# HEATING AND VENTILATION EVALUATION OF OFF-THE-SHELF HELICOPTER TRAINERS

Analyzed by Capt. Rothwell Date 14 June 1963

| | %CO | | Temp | |
|---|---|---|---|---|
| | A/C | Out | A/C | Out |
| VENTILATION | | | | |
| On Ground | | | | |
| Doors Off (P) | 0 | 0 | 94°F | 90°F |
| Doors On - Window Closed, Vent Open | 0 | 0 | 96°F | 90°F |
| Doors On - Window Closed, Vent Closed | 0 | 0 | 98°F | 90°F |
| Hover | | | | |
| Doors Off (P) | 0 | 0 | 92°F | 90°F |
| Doors On - Window Closed, Vent Open | 0 | 0 | 94°F | 90°F |
| Doors On - Window Closed, Vent Closed | .01 | 0 | 96°F | 90°F |
| In-Flight | | | | |
| Doors Off (P) | 0 | 0 | 90°F | 87°F |
| Doors On - Window Closed, Vent Open | 0 | 0 | 92°F | 82°F |
| Doors On - Window Closed, Vent Closed | 0 | 0 | 94°F | 82°F |

HEATING*

*Heater not present on this aircraft.

ANNEX "A"

PARAGRAPH B

HEADQUARTERS
UNITED STATES ARMY PRIMARY HELICOPTER SCHOOL
Fort Wolters, Mineral Wells, Texas

27 August 1963

AKPWO-HS

SUBJECT: Evaluation of Mission Suitability of the Primary Helicopter Trainer (Off-the-Shelf) USATECOM Project No. 4-3-1000-01-A

TO: President
US Army Aviation Test Board
Fort Rucker, Alabama

Attached hereto are reports of evaluation of mission suitability for the PH-1, PH-4, and PH-5 Helicopters.

/s/ J. E. Gonseth Jr
/t/ J. E. GONSETH JR
Colonel, Signal Corps
Commandant

3 Incl
1. PH-1
2. PH-4
3. PH-5

PARAGRAPH B

EVALUATION OF MISSION SUITABILITY

OF THE

PH-1 HELICOPTER AS CONDUCTED BY THE

UNITED STATES ARMY PRIMARY HELICOPTER SCHOOL

1. Scope. Experienced primary flight instructors from the US Army Primary Helicopter School conducted primary flight training with qualified student officers with no previous flight experience and transition training for rated Army aviators with varied experience in observation helicopters. The helicopter was repeatedly flown through typical training missions with the students being required to perform maneuvers included in the approved flight syllabus of the US Army Primary Helicopter School, Fort Wolters, Texas.

2. Findings.

a. Hovering.

(1) The student pilot is unable to adjust the cyclic trim control while at a hover due to the fact that he must release the collective pitch control with the left hand to make the required adjustments. The instructor pilot could not make any adjustments as the controls are located out of his reach. This precludes the instructor demonstrating the correct inflight trim application to the student. Although the control forces can be overridden by the pilot, prolonged operations with an out-of-trim condition becomes irritating and tiresome to the beginner aviator and detracts from the learning process.

(2) Directional Control is unacceptably sensitive for primary student training. The normal tendency of the student pilot to be late in correcting for errors and to overcontrol when corrective action is taken resulted in see-sawing action in all hovering work.

(3) Sufficient pedal control action was lacking at times for recovery from student errors and inadvertent unusual attitudes.

(4) The rate of movement to the point from which a safe recovery from unusual attitude can be made is reached exceedingly

fast, thereby allowing insufficient latitude for instructor pilot corrections. The student is afforded little opportunity to correct his own mistakes.

(5) The problems of directional control, insufficient pedal control and latitude for student error are magnified by a crosswind condition.

(6) Pilot posture due to seat and control relationship is very fatiguing.

b. Normal Takeoff and Normal Approach.

(1) Directional control is unacceptably sensitive for primary student training as the helicopter moved through effective translational lift into forward climbing flight and upon termination of the approach to a hover. A crosswind condition of 8-15 knots magnified the problems of directional control to the point where the primary student could not safely control the helicopter during the approach and termination. Considerable effort is required by the instructor to safely control the aircraft under similar conditions.

(2) The problem of directional control causes overcontrolling of other controls while trying to maintain a heading or to correct a heading error.

(3) Throttle and pitch coordination is unacceptably difficult for primary training.

(4) The airspeed indicator is unacceptably sensitive to minor attitude changes.

c. Maximum Performance Takeoff and Steep Approach.

(1) Directional control is unacceptably sensitive for primary student training during transition to normal climbing power after a maximum performance takeoff and during the termination of the steep approach to a hover. A crosswind condition of 8-15 knots magnified the problem of directional control to the point where the primary student could not safely control the aircraft during takeoff, approach, and approach termination to a hover. Considerable effort is required by the instructor to control the aircraft under similar conditions.

(2) The aircraft has a tendency to weathercock during a maximum performance takeoff in crosswind conditions. Inadvertent slow airspeed at this point of the takeoff results in insufficient pedal control to prevent the helicopter from going into uncontrollable turns during climb-out.

d. Running Takeoff and Landings.

(1) Directional control is unacceptably sensitive for primary student training as the helicopter taxied over the ground, as it broke ground on takeoff and upon ground contact and ground run during the landing.

(2) The action of the oleo struts contributes to the problem of directional and cyclic control on takeoffs and landings. During a crosswind takeoff, application of cyclic control into the wind depresses the upwind oleo and causes the downwind skid to lift off the ground. Prior to reaching translational lift, the limit of directional control is reached and the pilot is unable to compensate for the unequal skid drag condition. Inadvertent landing on one skid causes an unequal oleo action and skid drag, creating an area of pedal and cyclic action that is beyond the primary student's ability.

e. Hovering Autorotations.

(1) Low inertia rotor system imposes the need for exceptional skill and timing by the pilot. Yaw control and collective pitch application must be perfectly timed. This requirement for such precision is unacceptable for primary student training.

(2) In teaching this maneuver to a student, the instructor pilot would be required to accept an inordinate amount of risk during the "IP hands off" stage. There is little or no margin for error.

(3) Surprise or forced landings from a hover would be impossible to teach due to the spring loaded throttle. Spring load throws the throttle back to an "on" position, causing power surge.

(4) Power recoveries from hovering autorotations were not attempted because of the characteristic of the blade dampers to dephase at power surge.

f. Autorotations.

(1) Day and night autorotational landings were performed. This aircraft required a low flare of approximately twenty feet altitude with initial pitch application being made at approximately three feet with a continuous application until ground contact. The main rotor RPM decayed at a rapid rate after initial pitch application with subsequent reduction in directional control on landing runout. The flare altitudes, amount of flare, and altitude and amount of initial pitch application is unacceptably critical for primary student training due to the low inertia rotor system with a rapid rate of main rotor RPM decay at pitch application. The aircraft is not forgiving at this critical point of the maneuver and affords the instructor pilot little leeway for corrective action after normal student errors. The requirement for a low flare at approximately twenty feet of altitude with initial pitch application for cushioning the landing required at approximately three feet of altitude, develops such a rapid series of events that the primary student would be unable to learn the required touchdown techniques. The rapid decay of main rotor RPM after the initial application of collective pitch requires that the altitude of initial application be exact. The precision required at this critical point of the autorotation is such that there is little or no margin for error and dictates that the instructor pilot must ride the controls heavily at all times, thus continually leading the student through all control applications. This would greatly reduce the effectiveness of the Primary Course. A requirement for a power recovery due to student error at initial pitch application induces such a rapid series of events that the pilot is unable to maintain heading, regain operation rotor and engine RPM and return the aircraft to safe flight conditions.

(2) The spring loaded over-ride is such that a conscious effort must be made to hold the throttle in the over-ride position. This adds another area for division of attention and concentration.

(3) The autorotative characteristics outlined above are unacceptable for primary student training. They would be very detrimental to the student's mental composure and would adversely affect the learning process.

g. Simulated Forced Landings.

(1) The normal student delay in reducing the collective pitch to the full-down position and in making proper application of

right pedal for torque control in response to a power cut caused the main rotor RPM to decay below the lower safe limit of 400 RPM. No margin for student error is available. An inadvertent application of left pedal at power cut, an error not uncommon with primary students, causes an immediate tumbling roll towards the left front. Full right and full aft cyclic control combined with an immediate power recovery are required to recover from this unusual attitude.

(2) The loss of main rotor RPM and yawing to the left of approximately forty-five degrees at power cut would, for reasons of safety, require the instructor pilot to advise the student in advance of the maneuver and then heavily ride the controls, thus leading the student into the autorotational descent. This procedure would have to be continued throughout the course of instruction due to the inability of the students to react quickly enough to the required control inputs necessary to counteract the rapid changes of aircraft attitude and RPM loss. This would greatly reduce the effectiveness of the Primary Course.

(3) All of the autorotative touchdown characteristics listed under autorotations are unacceptable for primary student training during the teaching of simulated forced landing touchdowns.

h. Decelerations. Yaw control is unacceptably sensitive for primary student training.

i. Simulated Anti-torque Control Failure. Low inertia rotor system imposes the need for exceptional skill and timing by the pilot. Yaw control at entry to the maneuver and collective pitch application must be perfectly timed. This requirement for such precision is unacceptable for primary student training.

j. General.

(1) The clutch engagement cable is routed under a lead acid battery.

(2) The exhaust stacks are located on the bottom of the aircraft near the fuel drains constituting a fire hazard during confined area operations.

(3) The pilot is unable to check the oil between flights because the oil dip stick handle is too hot to touch.

(4) Any rapid application of throttle to join the needles or to apply power dephased the blade dampers inducing a condition conducive to ground resonance. Dephased blade dampers induced a severe vibration during descending powered flight and autorotative descent.

(5) There are too many control trims and control locks and they are only available to the student pilot. Students mistakenly applied friction locks when asked for cyclic trim.

(6) The clutch hand lever is completely out of the instructor's reach and he is entirely dependent upon the student for clutching and de-clutching. Rapid engagement of clutch will dephase the blade dampers, inducing a condition conducive to ground resonance or blade damage.

(7) This aircraft moves so rapidly into an extreme condition after a student induced error that the instructor pilot must maintain an extremely high level of alertness. This makes flight instruction in the aircraft exceptionally tiring and creates a feeling of tension during the flight that is detrimental to the presentation of instruction.

(8) The placement of the flight instruments does not coincide by association with the flight controls. This is detrimental to a good cross check. The RPM gauge, associated with the pilot's left hand and arm, is located on the right side of the console. The airspeed indicator, associated with the pilot's right hand and arm, is on the left side of the console.

(9) The collective pitch and throttle, when not frictioned, creep in flight and the engine RPM will drop 300 RPM or more in a fraction of a second if the pilot attempts to tune the radio, set trim, or make any other adjustments requiring the removal of his left hand from the collective pitch control.

3. Comparison with Criteria for Evaluation of Mission Suitability of "Off-the-Shelf" Primary Trainers. A comparison of the characteristics of the helicopter with the Criteria for Evaluation follows:

| Criteria for Evaluation | Helicopter Meets Criteria | Remarks |
|---|---|---|
| Flight Controls (Cyclic, collective and anti-torque): Must have a rapid response with no tendency to overshoot in response to corrections in powered and non-powered flight due to the general inability of the student pilot to treat any aircraft with the same finesse and care of a seasoned pilot. | NO | See par 2a, b, c, d, e, and g. |
| Stability: Inherent stability in the vertical, longitudinal and lateral axis that will absorb power changes (power to non-power and non-power to power, intentional/inadvertent) with minimum corrective action required to regain positive control. | NO | See par 2a, b, c, d, e, f, g, h, i, and j. |
| Power Reserve: Provide an adequate power reserve that will allow the instructor pilot to contain or recover from unusual situations induced by student errors. | YES | |
| Autorotative Characteristics: Rotor mass and inertia adequate to allow for student error in autorotative landings. | NO | See par 2e, f, g, and i. |
| Latitude for Student Error: Inherent flight characteristics that will allow a student to make an identifiable error and still have sufficient latitude for the student pilot and/or instructor pilot to make a recovery. No | NO | See par 2a, b, c, d, e, f, g, i, and j. |

| Criteria for Evaluation | Helicopter Meets Criteria | Remarks |
|---|---|---|
| preflight or starting technique that would demand detailed procedure or unusual knowledge on the part of the student and instructor pilot. | | |
| Training Endurance Considerations: Adequate ventilation, heating, and defrosting equipment. Ample shoulder room between IP and student, and between collective and door. Comfortable seat cushions to allow four hours of flight without undue fatigue. | NO | See par 2a(6) and j(7). |
| Location of Controls: Trim controls if required on each cyclic stick. Any control locking or safety devices in sight and reach of IP. | NO | See par 2a(1) and j(5) (6). |
| Ground Resonance: Must be free from ground resonance. | NO | See par 2e(4) and j(4) (6). |

4. Conclusions: The PH-1 is unsuitable for use as a Primary Helicopter Trainer.

PARAGRAPH C

HEADQUARTERS
DEPARTMENT OF THE ARMY
Office of the Assistant Chief of Staff for Force Development
Board for Aviation Accident Research

Fort Rucker, Alabama

BAAR-P 29 July 1963

SUBJECT: USABAAR's Evaluation of PH-1 Off-the-Shelf Primary Helicopter Trainer

TO: President
U. S. Army Aviation Test Board
ATTN: Off-the-Shelf Project Officer
Fort Rucker, Alabama

1. The following is USABAAR's evaluation of the PH-1 entry for the off-the-shelf primary helicopter trainer competition. The evaluation considered the categories of aviation safety and accident prevention in three primary categories. In each of these categories there are certain deficiencies which will detract from its mission capability and should be considered by those responsible for selecting the winner of the competition. Categories considered are:

a. Operational Safety - This category considers those features of the aircraft and its operating characteristics that are considered to be conducive to accident causation and which may detract from the operator's ability to maintain safe flight at all times.

b. Maintenance Safety - This category considers maintenance design features of the aircraft contributing to accident causation. It includes those features of "Murphy's Law," ease of inspection, accessibility for component replacement, the preflight inspection imposed on the operator, etc.

c. Crashworthiness - This category considers design features of the aircraft that, in the event of a crash, provide protection to the occupants from injury. It also includes features of crash-fire worthiness.

2. Evaluation comments are as follows:

a. Operational Safety

(1) Clutch engagement - No provisions are included to prevent starting the engine with the clutch engaged to prevent damper and rotor head damage.

(2) Engine instrument group - The mounting angle of the instruments makes readout difficult.

(3) Intercom system - A two position ICS/Transmit switch should be located on the cyclic control to preclude the need to remove hands from control grip in event of emergency.

(4) Pilot distraction and loss of visibility - The instruments are mirrored in the bubble during day and night. The light angle and the reflection characteristics of the bubble are such that during night and day operations, the instrument panel is noticeably visible in the bubble.

(5) Navigation lights - The light positioned above the bubble creates detracting reflections on the bubble at night. The modification that relocates the lights on the skid assembly appears to be more satisfactory.

(6) Instruments - Instrument legibility becomes blurred and difficult to read at night when using the landing light during final approach and hover. This deficiency is particularly noticeable when the instrument light is partially dimmed.

(7) Map light - There are none installed or proposed. Map lights should be installed to preclude the use of makeshift lights.

(8) Landing light - The fixed landing light causes excessive glare on the bubble when operating close to the ground.

(9) Transmission and pressure warning lights - The labels of these displays are not visible to the pilot.

(10) Engine exhaust - It is located approximately 15 inches from the ground and acts as an ignition source when operating in areas of tall dry grass.

(11) Skid shoe - The short skid shoe installation exposes skids to catching on ground objects. Installation of full length skid shoes is required to preclude snagging ground objects.

(12) Autorotation characteristics - The autorotation characteristics are such that more skill is required to perform this maneuver than is presently needed in any other helicopter presently in the Army inventory. USABAAR is of the opinion that this factor alone would make this helicopter unacceptable as a primary trainer.

b. Maintenance Safety

(1) Pitch change push-pull rods - The pitch change push-pull rods from the lower bell cranks to the main rotor system are susceptible to damaging lateral loads when used as hand holds. Their accessibility makes the occurrence very likely.

(2) Magnetic chip detector - Install magnetic chip detectors of the continuous readout type in the transmission and engine oil sumps.

c. Crashworthiness.

(1) Seat pan - Energy absorption in the vertical direction appears to be unsatisfactory. This is based on the amount of space available before the seat pan "bottoms out."

(2) Seat back rest -

(a) The space behind the back rest is accessible for the storing of odd items such as clipboards, tools, handbooks, etc. These items can contribute to crash injury.

(b) The energy absorption qualities of the thermoplastic material are unknown as to the extent they may protect against injury.

(3) Cyclic control - The design and position of the cyclic control makes it lethal in the production of injury.

(4) Shoulder harness and inertia reel - Any aircraft procurement must include these items to be acceptable to USABAAR.

(5) Seat belt - The attaching point is not self-aligning in all directions which makes it vulnerable to failure when lateral loads are applied.

(6) Cockpit integrity - The cockpit lacks structural members that will prevent impingement upon the occupants in the event of a crash.

(7) Fuel cell - The cell design is susceptible to rupture. Its immediate proximity to ignition sources creates a post-crash fire hazard.

3. The following features are recognized as desirable and considered worthy of mention:

a. Cyclic and pitch control forces are negligible.

b. The range of external vision from the cockpit is excellent.

c. The throttle and pitch controls are well correlated.

d. The design and the inspection requirements of this aircraft makes it easy for the pilot to perform his preflight.

/s/ Leo E. Bugeron
/t/ LEO E. BUGERON
Major, Arty
for

/t/ ROBERT M. HAMILTON
Colonel, Infantry
Director, USABAAR

## PARAGRAPH D

U. S. ARMY AVIATION HUMAN RESEARCH UNIT
Fort Rucker, Alabama

28 June 1963

Human Factors Evaluation: PH-1 Helicopter

1. Summary

1.1 The design philosophy of the PH-1 was in large part guided by human factors considerations related to the primary helicopter training mission. As a result, the aircraft was found to be highly satisfactory from the human factors standpoint. Design decisions in large part appear to have been resolved in favor of the crew, maintenance personnel, or freedom from maintenance; rather than maximization of performance parameters.

1.2 The major deficiencies noted were poor sideward visibility for tall personnel, an unsatisfactory location for the C-1611 Intercommunication Set Control, and failure to specify the manner of installation of shoulder harnesses. In its proposed location the C-1611 Control would be dangerous due to its sharp edges, difficult to use, and difficult to see. Specification of this relatively large control is regarded as unrealistic for this compact helicopter, and it is recommended that any Army purchase specify that the contractor provide the applicable functions of these C-1611 Controls at the location of the presently installed Interphone-Transmit switch, which is quite satisfactory.

1.3 Strong points were good visibility except as noted above, and good design from the standpoint of inspection and maintainability.

2. Detailed Considerations

2.1 Handling characteristics were regarded as generally satisfactory, with no major problems from the human factors standpoint.

2.2 Visibility was generally good.

2.2.1 View of instruments was good.

2.2.2 Forward and rearward visibility was good.

2.2.3 Downward visibility was satisfactory except for lack of view of the skids. Skid view is not of major importance for experienced pilots, but is of value for student orientation. If the PH-1 should be purchased, probably a skid reference would be improvised by attaching a stiff but yielding (like steel auto curb feelers or rubber goal line flag masts) extension to the skid.

2.2.4 Sideward visibility was good except for tall personnel. Sideward visibility at flight level will be poor for pilots above the 95th percentile in seat to eye height with the doors off, and down to about the 85th or 90th percentile with the doors on. Visibility is restricted more on the near side than on the far side. No seat adjustment is provided which would permit the eyes of tall individuals to be located at a level where satisfactory sideward visibility could be obtained.

2.3 Glare shields on the "Landing Light On" signal light and the "Transmission Oil Temperature and Pressure" warning signal lights mask their labels. The shield should be redesigned for the Transmission Oil Temperature and Pressure warning lights with the labels placed on it in a manner visible from both crew stations. The labels should be placed so that illumination of the indicator light will provide illumination of the appropriate label, or else the label should be placed on the lens of the indicator.

2.4 The "Landing Light On" indicator uses a red lens, which should only be used to indicate a dangerous situation requiring immediate action. A green or white lens should be used on this indicator. This is particularly advisable since a red indication could easily be confused with the adjacent transmission oil warning signals, or the transmission oil warning signals not noticed. Consideration should be given to eliminating the "Landing Light On" indicator.

2.5 The engine status indicators do not conform to desirable practices of arranging these in a way that indicates "OK" when they are aligned, but the present arrangement requiring separate reading of each indicator is considered preferable over an alignment scan arrangement. This is due to the fact that operational Army aircraft will all require separate reading of these indicators. When most operational Army aircraft employ alignment scan status indicators, then it would be desirable for the primary trainer to also incorporate this arrangement of indicators.

2.5.1 The arrangement of the Fuel Quantity, Amperes, Fuel Pressure, Cylinder Head Temperature, Engine Oil Pressure, and Engine Oil Temperature indicators used is regarded as less than optimum. Switching the location of the Engine Oil Temperature and Amperes indicators would be desirable.

2.5.2 The safe operating ranges of the Fuel Pressure, Cylinder Head Temperature, Engine Oil Temperature, and Engine Oil Pressure indicators are not easily determined under night instrument panel illumination. It is recommended that green and yellow operating range arcs be placed on these indicators with the same materials and widths as are used on the Engine-Rotor RPM indicator.

2.6 During night operation minor reflections were noted from cockpit lighting or tail boom rotating beacon. However these were not regarded as of concern for the intended night use of the primary helicopter trainer.

2.7 Dual trim controls are not provided. Trim controls for the left seat would be desirable when the instructor occupies this position. Quick adjustment of trim cannot easily be accomplished from the left seat while also controlling the helicopter. Linked trim controls permitting left handed trim adjustment from the left seat would be desirable.

2.8 The proposed location of the C-1611 Intercommunication Set Control was not satisfactory for the listed reasons.

2.8.1 The sharp edges of the C-1611 Control would present a hazard to both occupants.

2.8.2 The control would be difficult to see in the proposed location, and the head twisting required to see it would invite vertigo.

2.8.3 The control would be difficult to reach, particularly while wearing winter clothing.

2.8.4 A satisfactory alternate location for the C-1611 Controls could not be found.

2.8.5 The specification of the relatively large C-1611 Controls for this compact helicopter is regarded as unrealistic. All required functions of this control could easily be provided in a much smaller package which could be appropriately located.

2.8.6 It is recommended that any purchase of this helicopter specify that the contractor provide the applicable functions of the C-1611 Control, placing the controls at the panel level used for the "Intercom-Transmit" switch of the evaluated aircraft.

2.8.6.1 The specified controls could be placed outside the cockpit, and the applicable controls wired to operate at the panel level used for the "Intercom-Transmit" switch of the evaluated aircraft, but this is not considered desirable.

2.8.6.2 It is believed that the contractor could provide the required functions at less cost than that of the C-1611 Intercommunication Set Control.

2.9 The proposal did not specify the manner of installation of the shoulder harness. It was mentioned that the basic design included mounting points for shoulder harnesses.

2.9.1 This appears to be an oversight on the part of the contractor.

2.9.2 This is considered a definite deficiency as the proposal stands.

2.10 It was noted that the rear side of the tilting seat back separated from the forward side of the rivet points. A stronger material, better attachment, or a single mould is recommended to prevent this separation.

2.11 The tinted bubble panels above and behind the crew positions are desirable as a means of reducing radiation and temperatures imposed on the crew during hot weather.

2.12 The plastic used for the seat back could be uncomfortable when sweating under hot conditions. Consideration should be given

to perforating this plastic in order to provide some ventilation of the back, providing structural properties are not impaired.

2.13 The heater installation appears to be capable of providing adequate heat and bubble de-fogging.

2.14 The anti-torque pedals are designed in a manner that might permit their edge to hook under the instrument panel plastic cover at the side seam. Screws working out at the seam, the flat straight edge of the pedal, and the shortest pedal position of the four proposed, could combine to make forward inside pedal movement impossible.

2.14.1 Either the position of the seam should be moved well aft of maximum pedal deflection, or else the edge of the pedal should be designed to preclude catching on this seam.

2.15 The aircraft is outstanding from the standpoint of inspection and maintenance. The design minimizes the frequency and number of required lubrication and maintenance operations. Visibility of and access to components is very good, and the design facilitates most maintenance operations.

2.15.1 The engine oil level dipstick and filling hole are difficult to reach. A special device for adding oil is listed as an available part, and is needed. A permanently-mounted device extending both the dipstick and filling hole to an accessible position is desirable.

2.15.2 Changing the position of the ground handling wheels requires two men. A tool could be designed to enable one man to accomplish this, and should be considered.

/s/ Robert H. Wright, Ph.D.
/t/ ROBERT H. WRIGHT, Ph.D.
Research Scientist

## UNIT B - COMPANY B MODEL PH-4

## SECTION ONE

## USAAVNTBD REPORT

A. Description of Materiel.

1. The PH-4 is a single-engine, three-place, side-by-side, two-bladed single rotor and tail rotor type helicopter. Power is supplied by a VO540-BID six-cylinder, opposed type air-cooled engine which provides maximum rated power at sea level of 305 b.hp. at 3200 r.p.m. Engine power is transmitted to the rotors through a double planetary reduction transmission. The main rotor mast assembly is set into the transmission, which is bolted to the engine, making the complete assembly one rigid unit. Takeoff shaft connections extend from the transmission to drive the tail (antitorque) rotor.

2. Flight controls consist of cyclic, collective pitch, and antitorque pedals. A motor-driven-type cyclic trim system is provided. An adjustable friction device is provided for the collective pitch control.

3. The main rotor system is a two-bladed, teetering, underslung rotor. Aerodynamic "paddles" are mounted at 90 degrees to each main-rotor blade and are linked through the fixed and rotating swash plates and push-pull tubes to the cyclic controls to provide pitch and roll control of the helicopter. A two-bladed, all-metal, antitorque tail rotor mounted on a flapping hinge provides directional control.

4. The helicopter basic body section and tail boom are of all-metal stressed-skin construction. A baggage compartment with 125-pound capacity is located aft of the tail-cone attaching point. A 1000-pound cargo sling with manual and electrical releases is provided. The helicopter has a skid-type landing gear with removable ground-handling wheels.

5. General dimensions of the helicopter submitted for test are listed below:

| | | |
|---|---|---|
| a. | Overall height | 10 feet 2.25 inches |
| b. | Overall length (main rotor tip to tail rotor tip) | 40 feet 6.0 inches |

c. Rotor diameter 35 feet

d. Fuselage width 4 feet 11.2 inches

e. Skid gear tread 7 feet 6.0 inches

B. Scope of Test. The test was conducted in the vicinity of Fort Rucker, Alabama, by USAAVNTBD project officers and USAPHS primary helicopter instructors. The tests consisted of three phases: a 60-flying-hour test, a study of the manufacturer's technical proposals which described changes to configure the test helicopter to meet the stated requirements, and a comparison of the helicopter with the Model Specification and the Statement of Requirement. In addition, the US Army Board for Aviation Accident Research (USABAAR) evaluated the aviation safety aspect; the US Army Aviation Human Research Unit (USAAHUMRU) evaluated the human factors aspect; and the US Army Aeromedical Research Unit (USAARU) evaluated noise level, internal lighting and heating and ventilation.

C. Tests.

1. Evaluation of Physical and Flight Characteristics, Performance, Mission Suitability, and Maintenance.

a. Physical Characteristics.

(1) Basic and Operating Weights. The helicopter was weighed as delivered with oil and trapped (unusable) fuel. To this weight (1824 pounds), the weight of electronic and auxiliary equipment required for Army use (92 pounds) was added, and the weight of currently installed equipment not required for Army use (61 pounds) was subtracted, resulting in a total estimated basic weight of 1855 pounds. The estimated mission operating weight was then computed by adding to the estimated basic weight the weight of fuel (276 pounds) and 400 pounds (instructor and student). Details follow:

| | |
|---|---|
| EMPTY WEIGHT as weighed (less ground-handling wheels) | 1824 lb. |
| Required equipment to be added: | |
| Shoulder harness and inertia reel (2 ea) | 6 lb. |

| | | |
|---|---|---|
| First-aid kit and fire extinguisher | 10 lb. | |
| AN/ARC-45 (UHF) | 27 lb. | |
| C-1611 interphone (2 ea.) | 4 lb. | |
| Attitude indicator (proposed) | 3 lb. | |
| Inverter (proposed) | 8 lb. | |
| MA-7 battery | 34 lb. | |
| TOTAL ADDED | 92 lb. | 92 lb. |
| | | 1916 lb. |
| Weight of installed equipment to be removed: | | |
| Commercial radio | 15 lb. | |
| External cargo sling | 9 lb. | |
| Baggage compartment | 9 lb. | |
| Battery | 28 lb. | |
| TOTAL SUBTRACTED | 61 lb. | -61 lb. |
| TOTAL BASIC WEIGHT (estimated) | | 1855 lb. |
| Fuel | | 276 lb. |
| Instructor and Student | | 400 lb. |
| MISSION OPERATING WEIGHT | | 2531 lb. |
| REMAINING AVAILABLE PAYLOAD | | 269 lb. |
| MAXIMUM CERTIFICATED GROSS WEIGHT | | 2800 lb. |

(2) Center-of-Gravity Travel. Control travel was sufficient to provide control at the extremes of allowable center-of-gravity (CG) position at maximum certificated and normal operating gross weights. The addition, removal, or relocation of ballast or aircraft components was not necessary for the helicopter to remain within CG limits when changes were made in loading of the helicopter with respect to fuel, instructor, and student.

(3) Ground Clearance. Ground clearance was sufficient for operation in unimproved areas. At normal operating r.p.m., ground-to-main-rotor clearance was satisfactory with cyclic stick centered but did not meet specifications when cyclic was fully displaced.

(4) Ground-Handling Characteristics. Ground-handling characteristics of the helicopter, with removable wheels provided, were satisfactory.

(5) Suitability for Hoisting, Jacking, and Mooring. The helicopter was equipped with suitable jacking hard points and had suitable locations on the structure for attachment of mooring lines. Special hoisting straps, presently in the Army system, are required for hoisting the helicopter.

(6) Suitability of External Power Receptacle. The helicopter was equipped with an external power receptacle which was compatible with Army APU's.

(7) Adequacy of Cockpit Configuration and Arrangement. The cockpit configuration and arrangement of the test helicopter were evaluated except for those items changed in the manufacturer's technical proposal. The cockpit configuration and arrangement were satisfactory except for the following:

(a) The center-left seating arrangement was unsatisfactory because of the close proximity of the student's (center) collective control to the instructor's (left) seat.

(b) Engine power could be decreased when throttle friction was applied.

(c) The manifold pressure bleed-air control was located behind the left instrument console ash tray and was inaccessible.

(d) Installed seat belts did not meet military specification.

(e) The heater installed was unsatisfactory because it could not be used during hovering flight (see paragraph D, section two).

(8) Suitability of Internal Lighting. The USAARU evaluation (paragraph A, section two) is summarized as follows: "The cockpit and instrument panel illumination met Model Specifications."

(9) Suitability of External Lighting.

(a) The position lights located on the forward cross tubes were satisfactory and caused no distracting reflections in the cockpit.

(b) The landing light, ground adjustable, installed on the helicopter was satisfactory.

(c) The anti-collision rotating beacons installed on the helicopter were satisfactory and were located to prevent reflection into the cockpit.

(10) Durability and Reliability. Durability and reliability could not be determined within the relatively short test time specified.

(11) Transportability. The helicopter is capable of being transported by C-123/130 type aircraft and by surface transport.

(12) Noise Level. The USAARU evaluation (paragraph A, section two) is summarized as follows: "Internal and external sound pressure levels met the Statement of Requirement. However, numerous internal measurements exceed the military specifications for acoustical noise levels in Army aircraft."

b. Flight Characteristics. The helicopter was flown at gross weights up to the maximum certificated (2800 pounds). The following were determined:

(1) Stability. Stability was satisfactory. Momentary "hands-off" cruising flight was possible for all but moderate-to-severe turbulent conditions.

(2) Controllability. Controllability was satisfactory. Control response was positive and of a rate suitable for primary helicopter training. Control travel was adequate to provide the necessary controllability for maneuvers performed in primary helicopter training.

c. Performance. The helicopter was flown at the maximum certificated gross weight (2800 lb.) and estimated mission operating

weight (2531 lb.) to determine whether it met the performance criteria stated in the Model Specification. The following was determined:

(1) The helicopter was capable of cruising at 65 knots true airspeed (TAS) at sea level.

(2) Endurance at 65 knots (TAS) was:

(a) 2.6 hours at 2800 pounds at 4600 feet density altitude.

(b) 3.0 hours at 2531 pounds at 3600 feet density altitude.

(3) Hover-out-of-ground effect was accomplished at a density altitude of 4400 feet which is equivalent to a pressure altitude of 1000 feet with an ambient temperature of 110°F.

(4) The rates of climb under ICAO sea level standard day conditions at 45 knots (TAS) were:

(a) 1330 feet per minute at 2800 pounds (maximum gross weight).

(b) 1700 feet per minute at 2531 pounds (mission operating weight).

(5) The autorotational performance was determined at 4400 feet density altitude (1000 feet pressure altitude, 110°F.) and at true airspeeds of 43 knots for maximum gross weight and 42 knots for estimated mission operation weight. Tested under these conditions, the rates of descent were:

(a) 1800 feet per minute at 2800 pounds.

(b) 1820 feet per minute at 2531 pounds.

(6) In autorotation under those conditions (paragraph (5) above), the helicopter regained normal rotor r.p.m. following a decay of rotor r.p.m. to the lower operating limit with an average of a 150-foot loss of altitude.

(7) The helicopter was not susceptible to ground resonance.

(8) The helicopter was landed cross slope on 15-degree slopes; however, with the left skid up-slope insufficient cyclic control caused a condition of mast-bumping.

d. Mission Suitability. This portion of the test was conducted by the USAPHS. Their report (paragraph B, section two) is summarized as follows:

"The PH-4 Helicopter is suitable for the training mission. The evaluation considered the areas of flight controls, stability, power reserve, autorotative characteristics, latitude for student error, training endurance, location of controls and ground resonance. In each of these areas, USAPHS found the aircraft acceptable for its intended mission."

e. Maintenance.

(1) During the evaluation the helicopter was maintained by the manufacturer's representative with military personnel provided for servicing, general assistance, and maintenance of records. The helicopter required only organizational maintenance. Maintenance requirements will not differ from those of Army helicopters presently used for a primary helicopter training mission.

(2) Throughout the evaluation, 80/87 octane fuel was used because of the type of engine installed. However, the VO540-9 engine included in the manufacturer's technical proposal will operate satisfactorily on standard Army aviation fuels (115/145) and lubricants.

(3) The helicopter was easy to service and maintain.

(4) Tools and ground support equipment normally found at the organizational level were adequate for organizational maintenance. Special tools are required for higher echelons of maintenance.

2. Evaluation of Manufacturer's Technical Proposal. The manufacturer's technical proposal to configure the test helicopter to meet Model Specification was reviewed and the following was determined:

a. The location of radio and intercommunication controls was satisfactory.

b. Inertia reels, which are necessary for shoulder harnesses for the primary helicopter training mission, were not specified.

c. Floor-mounted and cyclic-control-mounted radio-interphone keying switches were provided for both student and instructor pilot stations.

d. Alternate left-right seating proposal is considered superior to seating arrangement installed on test helicopter (left, instructor; center, student), because of improved visibility for student and elimination of the possibility of the instructor interfering with the student pilot's collective pitch movements.

e. An attitude indicator was provided.

f. The USABAAR evaluation (paragraph D, section two), is summarized as follows:

"The evaluation considered the categories of Operational Safety, Maintenance Safety, and crashworthiness. In each of these categories, USABAAR found the aircraft to be acceptable for its intended mission."

g. The USAAHUMRU evaluation (paragraph D, section two) is summarized as follows:

"The human factors design of the crew area of the PH-4 primary training helicopter was found to be adequate for mission accomplishment with the exception of the heating system which is considered unsatisfactory."

3. Comparison with Model Specification and Statement of Requirement. In determining whether the PH-4 met the requirements of the Model Specification and Statement of Requirement, the characteristics of the helicopter as tested and an evaluation of the manufacturer's technical proposal were considered.

a. Comparison with Model Specification as Amended.

| Mod. Spec. Para No. | Model Specification As Amended | PH-4 Meets Spec. | Remarks |
|---|---|---|---|
| 1. | SCOPE. | | |
| | Scope. This detail specification covers | | |

| Mod. Spec. Para. No. | Model Specification As Amended | PH-4 Meets Spec. | Remarks |
|---|---|---|---|
| | the essential requirements for the design of a single engine primary helicopter trainer capable of performing the mission specified in 1.2. | | |
| 1.1.1 | Designation and General Description. | | |
| | Army Model Designation - Primary Helicopter Trainer (Army Model Number not yet assigned). | | |
| | Number of Crew - 1 pilot | Yes | |
| | Number of Passengers - 1 student | Yes | |
| | Crew and Passenger Seating Arrangement - Side by Side | Yes | |
| | Flight Controls - Dual | Yes | |
| | Type of Engine - Reciprocating | Yes | |
| | Main Rotor System - Single | Yes | |
| 1.2 | Mission. The primary Army mission for which this helicopter will be employed is training of military pilots in the basic operation and performance of a helicopter. Training will | Yes | |

| Mod. Spec. Para. No. | Model Specification As Amended | PH-4 Meets Spec. | Remarks |
|---|---|---|---|
| | be accomplished under conditions to which Visual Flight Rules apply. | | |
| 1.3 | Federal Aviation Agency Certification. The helicopter will have a Part 6 standard airworthiness certificate issued by the Federal Aviation Agency. | Yes | |
| 1.4 | Perfo rmance Information. Those items of performance stated as requirements herein which are not included in the FAA approved flight manual are subject to verification by the US Army. | Yes | |
| 2. | APPLICABLE DOCUMENTS. | | |
| 2.1 | The documents applicable to this specification are those necessary to fulfill the requirements of paragraph 1.3, Federal Aviation Agency Certification. | Yes | |
| 3. | REQUIREMENTS. | | |
| 3.1 | Basic Weight. The basic weight of the helicopter will include all required installed equipment including the items of paragraphs | Yes | |

| Mod. Spec. Para. No. | Model Specification As Amended | PH-4 Meets Spec. | Remarks |
|---|---|---|---|
| | 3.7, 3.8.1.1, 3.8.1.2 and the Electronic Equipment as stated in Table E, Appendix I. | | |
| 3.2 | Center of Gravity Travel. Addition, removal or relocation of ballast or aircraft components will not be necessary in order to maintain the CG within CG limits due to changes in loading of the helicopter with respect to fuel, pilot and student. | Yes | |
| 3.3 | Useful Load. The useful load of the helicopter will be sufficient for 400 lbs. in addition to the fuel and oil necessary to accomplish the 2 1/2-hour endurance mission specified in paragraph 3.4.1. | Yes | |
| 3.4 | Required Performance. | | |
| 3.4.1 | ICAO Sea Level Standard Day Performance. (at certificated gross weight) | | |
| | Cruise Speed (Minimum) - 65 knots | Yes | |
| | Endurance (Minimum) - 2 1/2 hours at 65 knots cruise speed | Yes | |
| | Rate of Climb (Minimum - 1000 ft. per minute | Yes | |

| Mod. Spec. Para No. | Model Specification As Amended | PH-4 Meets Spec. | Remarks |
|---|---|---|---|
| 3.4.2 | Hovering Performance Requirement. At certificated gross weight the aircraft shall hover out of ground effect at 1000 ft. at 110°F. | Yes | |
| 3.4.3 | Autorotation Characteristics. (at certificated gross weight) | | |
| 3.4.3.1 | Normal Autorotation Speed. The manufacturer will designate a speed for normal autorotation not to exceed 45 knots. | Yes | |
| 3.4.3.2 | Rate of Descent. At the speed designated in 3.4.3.1 the helicopter will not exceed a stabilized autorotation rate of descent of 2200 feet per minute under conditions of 1000 ft. altitude and 110°F. | Yes | |
| 3.4.3.3 | Rotor R.P.M. Decay. In autorotation at the speed in 3.4.3.1 and conditions of 1000 ft. and 110°F, if rotor R.P.M. decays to the lower rotor R.P.M. limit, the helicopter will be capable of | Yes | |

| Mod. Spec. Para. No. | Model Specification As Amended | PH-4 Meets Spec. | Remarks |
|---|---|---|---|
| | regaining normal operating R.P.M. (as specified by the manufacturer) and with an altitude loss not to exceed 200 feet. | | |
| 3.5 | Aircraft Structure. | | |
| 3.5.1 | Landing Gear. | | |
| 3.5.1.1 | Type Landing Gear. Skid type landing gear which will permit running takeoffs and landings. | Yes | |
| 3.5.1.2 | Slope Landings. The landing gear will permit cross slope landing on slopes of 15°. | Yes | With left skid upslope, insufficient cyclic control caused a condition of mast bumping. |
| 3.5.1.3 | Ground Handling. Ground handling wheels are required. Weight of the ground handling wheels will not be included in the weight empty if they are detachable. | Yes | |
| 3.5.1.4 | Hoisting, Jacking and Mooring. Provisions will be made for hoisting, jacking and mooring. | Yes | |
| 3.5.2 | Main Rotor Blades. | | |

| Mod. Spec. Para No. | Model Specification As Amended | PH-4 Meets Spec. | Remarks |
|---|---|---|---|
| 3.5.2.1 | Blade Interchangeability. The main rotor blades will be individually interchangeable. | Yes | |
| 3.5.3 | Control Pedals. Both sets of directional control pedals of the aircraft will be adjustable. | Yes | |
| 3.5.4 | Operating Environment. | | |
| 3.5.4.1 | Aircraft Operation. The aircraft will be capable of operating in temperatures from $0^{\circ}$F to $+100^{\circ}$F. | Undetermined | Temperatures during tests ranged from $75^{\circ}$F. to $95^{\circ}$F. |
| 3.5.4.2 | Cabin Heating. The aircraft will have a heating system which provides a minimum of $50^{\circ}$F. cabin temperature with $0^{\circ}$F. outside air temperature. This condition need only be satisfied with the engine operating. | Undetermined | Heater operation was prohibited during hover. Due to temperature ranges, test could not be conducted. |
| 3.6 | Fuel and Lubricants. The engine will operate on such fuel and lubricants which are now established as standard by the US Army. (Ref: MIL G-5572C dated 12 Jul 60 & MIL-L-2285i dated 30 Jun 61 & MIL-L-6082C dated 18 May 61). | Yes | |
| 3.7 | Instruments and Navigational Equipment. Flight | Yes | |

| Mod. Spec. Para. No. | Model Specification As Amended | PH-4 Meets Spec. | Remarks |
|---|---|---|---|
| | instruments and lights for day and night VFR conditions shall be furnished and installed by the contractor. | Yes | |
| | An attitude indicator shall be provided as part of the basic aircraft instrumentation. | Yes | |
| 3.8 | Electrical. | | |
| 3.8.1 | Lighting. | | |
| 3.8.1.1 | Anti-Collision Light. The aircraft will have an anti-collision light. The light will be located to prevent reflection into the cockpit. | Yes | |
| 3.8.1.2 | Landing Light(s). The aircraft will be equipped with landing light(s) which will be adjustable. The landing light switch will be located on the pilot's cyclic or collective control. | Yes | |
| 3.8.2 | Power Receptacle. The aircraft will be equipped with an external power receptacle of an AN or AMS standard design. | Yes | |
| 3.8.3 | Switches and Auxiliary Controls. All switches and auxiliary controls | Yes | |

| Mod. Spec. Para No. | Model Specification As Amended | PH-4 Meets Spec. | Remarks |
|---|---|---|---|
| | necessary for flight and navigation will be accessible and within reach of the student pilot and the instructor pilot. Switches and controls shall be operable in flight by personnel wearing winter flight clothing. | | |
| | Accessible floor mounted and cyclic control mounted radio-interphone switches will be provided for both student pilot and instructor. | Yes | |
| 3.9 | Electronic Equipment. The aircraft will be equipped with the electronic equipment as indicated in Appendix I. | Yes | |
| 3.10 | Safety Equipment. Seat belt and shoulder harness will be furnished for all occupants. | Yes | Seat belts did not meet military specification. |
| | Appendix I | | |
| | Communication | | |
| | UHF - AN/ARC-45, 1 ea. | Yes | GFE |
| | ICS - C-1611, 2 ea. | Yes | GFE |
| | Miscellaneous | | |
| | Antenna - AT-450/ARC, 1 ea. | Yes | GFE |

| Mod. Spec. Para. No. | Model Specification as Amended | PH-4 Meets Spec. | Remarks |
|---|---|---|---|
| | Battery - Sonotone MA-7, 1 ea. | Yes | |
| | Inverter (If required either inverter listed with be a suitable substitute for standard equipment.) - Leland MIL-E-93-200 or Bendix 328-172-1, 1 ea. | Yes | Technical proposal specified MIL-E-93-200. |

b. Comparison with Statement of Requirement. A comparison with the Statement of Requirement (reference 4) excluding those requirements covered by the Model Specification, follows:

| Requirement | PH-4 Meets Requirement | Remarks |
|---|---|---|
| Size | | |
| It is desired that the external dimensions of the helicopter, less rotor, not exceed 8 feet in height, 23 feet in length, and 7 feet in width. | No | Helicopter height was 10.02 feet, length was 27.8 feet, and width was 7.5 feet. |
| With full cyclic movement, the rotor blade tip clearance above the ground level should not be less than 6 feet with rotors turning. | No | With cyclic centered and at normal rotor r.p.m., ground-to-main-rotor clearance was satisfactory. |

| Requirement | PH-4 Meets Requirement | Remarks |
|---|---|---|
| **Size** | | |
| A minimum rotor diameter consistent with good autorotative characteristics is desired. | Yes | |
| **Structure and Design** | | |
| The following will be required: Main rotor blades which are interchangeable, without retracking desirable. | Yes | |
| If more than two main rotor blades, provisions should be provided for simple expeditious folding and unfolding. | N/A | |
| It shall be free from ground resonance. | Yes | |
| Suitable seat belts and shoulder harnesses for both student pilot and instructor. | No | Seat belts did not meet military specification and shoulder harnesses with inertia reels were not proposed. |
| **Electrical** | | |
| The following are required: Lighting; adequate position, cockpit, anti-collision and landing lights for night flight. Position and anti-collision lights to be positioned to prevent reflection into cockpit; landing light to be adjustable. | Yes | |

| Requirement | PH-4 Meets Requirement | Remarks |
|---|---|---|
| **Durability and Reliability** | | |
| Engine and dynamic components should not be materially affected by dust, sand, moisture, etc., encountered in operation from unprepared areas. | Undetermined | |
| **Noise Level** | | |
| The lowest possible noise level is desired without use of a complex or elaborate muffler system or extension or heavy insulation. | Yes | Exceeded MIL-A-8806 in all areas (paragraph A, section two). |
| **Personnel Considerations** | | |
| No new personnel skills will be required. | Yes | Due to similarity of helicopter to other helicopters in Army inventory, no new skills will be required. |
| **Training Considerations** | | |
| No new training requirements will be generated. | Yes | No new training requirements for technical service schools are required. |
| No supporting training devices other than those on hand at the US Army training base are required. | Yes | |

D. Deficiencies and Shortcomings.

1. The following deficiency was noted during conduct of the test:

| Deficiency | Suggested Corrective Action |
|---|---|
| Inertia reels were not provided or included in the proposal. | Install suitable inertia reels. |

2. The following shortcomings were noted during conduct of the test:

| Shortcomings | Suggested Corrective Action |
|---|---|
| a. Manifold pressure purge control location not accessible. | Relocate manifold pressure purge control to an accessible position. |
| b. Center - left seating arrangement was considered unsatisfactory because of the close proximity of the student's collective control to the instructor's position. | Provide left-right seating arrangement. |
| c. Engine power can be inadvertently decreased when increasing throttle friction. | Provide throttle friction that tightens with application of power. |
| d. The tail boom "Pogo" stick was unsatisfactory. | Install tail rotor guard. |
| e. Magnetic chip detectors were not installed. | Install magnetic chip detectors of the continuous read-out type in the transmission engine oil sumps. |
| f. Heater could not be operated at a hover. | Relocate heater intake valve. |

## SECTION TWO

### Reports from Other Agencies on the PH-4

PARAGRAPH A

Aviation Field Operations Division
U. S. ARMY AEROMEDICAL RESEARCH UNIT
Fort Rucker, Alabama 36362

USAARU-FO

6 August 1963

# LIGHT EVALUATION OF THE PH-4

1. Methods and Equipment.

a. The evaluation consisted of in-flight analysis of the aircraft's lighting system under night conditions. Criteria for this evaluation were derived from U.S. Navy Specifications governing cockpit and instrument panel illumination modified to meet Army requirements.

b. A standard Norwood photo-electric meter was used to measure overall cockpit illumination from the auxiliary hand light or map light.

2. Results. (See Annex A)

3. Discussion.

a. Reflections from the instrument panel lights were noted on the right and left sides of the bubble.

b. Reflections from the grey painted cockpit interior were noted on the bubble.

c. Warning and caution lights should be dimmed for night operations to safeguard the pilot's night vision (Transmission Oil Pressure, Transmission Oil Temperature).

d. The Grimes anticollision light mounted on the mast produced a stroboscopic reflection on the rotor blades. The reflection is reduced to a minimum due to the flat black paint on the rotor blades. However, as the blade surfaces wear and become shiny, or if other light colored blades are installed, the stroboscopic reflection could present a problem.

4. Summary. If the deficiencies mentioned above are corrected, the aircraft will meet military illumination standards for a primary helicopter.

/s/ William C. Thrasher
/t/ WILLIAM C. THRASHER
2/Lt., MSC
Ass't Chief, Avn Fld Opns Div

1 Incl
as

Aviation Field Operations Division
U. S. ARMY AEROMEDICAL RESEARCH UNIT
Fort Rucker, Alabama

COCKPIT LIGHT STUDY
PH-4

1. Are all instruments adequately illuminated? Yes.

2. Are they illuminated uniformly? Yes. Is there sufficient intensity? Yes.

3. Is illumination controllable to very low intensities? Yes (Rheostat)

4. Are markings of instruments readable? Yes.

5. Are all controls, instructions, and nameplates adequately illuminated? Yes.

6. Are they illuminated uniformly? Yes. Is there sufficient intensity? Yes.

7. Is illumination controllable to very low intensities? Yes.

8. Are markings on controls, instructions and nameplates readable? ------

9. Is the intensity of lighting for some instruments and controls controlled separately? ------

10. Is floor lighting provided? Yes. Is the light standard red? Yes (also white light)

11. Is the power source independent of normal lighting circuit? Yes.

12. Are there any sources of light which give other than standard red light? No.

13. Are there any reflections in the windshield, windows, canopy or other reflecting surfaces which interfere with visibility inside or outside the cockpit? Yes (note para. 3a, b)

14. Is there light leakage into the cockpit from other compartments? No.

15. Are spare lamps provided in sufficient quantity and easily accessible? N/A

16. Are all instruments, instructions, nameplates, and control markings readable in daylight? Yes.

17. Can warning and caution lights be dimmed sufficiently for night operations? No (note para 3c).

18. Are warning and caution lights of sufficient intensity for daylight use? Yes.

19. Are warning and caution lights on the main dimming circuit? No.

20. Is lighting provided in accordance with the aircraft detail specification? -----

21. Is the auxiliary light adequate for reading? Yes.

22. Does the light cause glare to cockpit? No.

23. Is there adequate general illumination for the compartment? Yes.

24. Do any of the exterior lights provide glare in the cockpit? No. (note para 3d)

25. Is exterior lighting provided in accordance with FAA? Yes.

Map light rated at 32 footcandles with the light 14 inches from the photometer.

AD-A033 205 ARMY AVIATION TEST BOARD FORT RUCKER ALA F/G 1/3
MILITARY POTENTIAL TEST OF COMMERCIAL 'OFF THE SHELF' HELICOPTE--ETC(U)
JAN 64 W S DAVIS, H G SMITH

UNCLASSIFIED NL

2 OF 4
AD A033205

Aviation Field Operations Division
U. S. ARMY AEROMEDICAL RESEARCH UNIT
Fort Rucker, Alabama 36362

USAARU-FO

6 August 1963

REPORT ON PH-4

1. Method of Testing.

a. The heating and ventilation evaluation of the PH-4 model consisted of comparisons of outside air temperature and cockpit air temperature with the aircraft under all operating conditions. In conjunction with these checks, a carbon monoxide test was also made.

b. Equipment consisted of:

(1) Weston Aneroid Thermometer, Model 2291.

(2) Mine Safety Appliance Company Carbon Monoxide Tester, Category No. DS-47133.

2. Results. (See Annex A)

3. Discussion.

a. Although high temperatures were encountered on the aircraft with doors on, windows closed, and vents closed (see Annex A), this aircraft will rarely if ever, be operated under these conditions with existing outside temperature at 86°F.

b. The recommended maximum temperatures for clothed men not especially acclimatized are as follows:

(1) Resting in still air - 88°F.

(2) Resting, with some air movement (170 FPM air velocity) - 93°F.

(3) Moderate work, still air - 78°F.

Reference: Patty, Frank A., Industrial Hygiene & Toxicology (2d ed., Vol. 1; New York: Interscience Publishers Inc., 1958).

c. Comparing recommended working temperatures (see above) with temperatures found in aircraft (see Annex A), a mean working temperature of 95°F. was derived.

d. Carbon monoxide was not found in this aircraft at any time.

e. Heater was not checked on this aircraft due to extreme outside temperatures.

/s/ J. C. Rothwell
/t/ J. C. ROTHWELL
Captain, MSC
Ass't Chief, Avn Fld Opns Div

1 Incl
as

PH-4

## HEATING AND VENTILATION EVALUATION OF OFF-THE-SHELF HELICOPTER TRAINERS

Analyzed by: Captain Rothwell Date: 6 August 1963

| | % CO | | Temp | |
|---|---|---|---|---|
| VENTILATION | A/C | Out | A/C | Out |
| On Ground | | | | |
| Doors Off (P) | 0 | 0 | 92°F | 86°F |
| Doors On - Window Open | 0 | 0 | ---- | ---- |
| Doors On - Window Closed, Vent Open | 0 | 0 | 96°F | 86°F |
| Doors On - Window Closed, Vent Closed | 0 | 0 | 102°F | 86°F |
| Hover | | | | |
| Doors Off (P) | 0 | 0 | 92°F | 86°F |
| Doors On - Window Open | 0 | 0 | ---- | ---- |
| Doors On - Window Closed, Vent Open | 0 | 0 | 102°F | 86°F |
| Doors On - Window Closed, Vent Closed | 0 | 0 | 104°F | 86°F |
| In-Flight | | | | |
| Doors Off (P) | 0 | 0 | 84°F | 83°F |
| Doors On - Window Open | 0 | 0 | ---- | ---- |
| Doors On - Window Closed, Vent Open | 0 | 0 | 90°F | 83°F |
| Doors On - Window Closed, Vent Closed | 0 | 0 | 100°F | 83°F |

HEATING*

*Heat check not performed.

Annex A

Aviation Field Operations Division
U. S. ARMY AEROMEDICAL RESEARCH UNIT
Fort Rucker, Alabama 36362

USAARU-FO 6 August 1963

# NOISE EVALUATION OF THE PH-4

1. Methods and Equipment.

a. Due to the number of aircraft to be tested and the short time available, the noise analysis was limited to the following:

(1) "A" - 25-55 db: sound level for speech interference.

(2) "B" - 55-85 db: sound level for noise survey.

(3) "C" - 85-140 db: sound pressure level--over-all frequency response.

b. A General Radio, Sound-Level-Meter, type 1551-C, was used for the noise measurements.

c. The test area, located at County Line Strip, is a pre-marked compass rose with a 50 foot radius.

2. Results. (See Annex A)

3. Discussion.

| | Doors On | Doors Off | MIL-A-8806 |
|---|---|---|---|
| Normal cruise | 107 | 115 | 106 |
| Maximum cruise | 113 | 118 | 113 |

a. Operation of this helicopter at normal and maximum cruise with the doors on and off produced excessive sound pressure levels as shown above. These noise levels exceed Tables I and IV MIL-A-8806.

b. There are no military specifications for external noise. Raw data is included for purpose of comparison only.

USAARU-FO 6 August 1963
SUBJECT: Noise Evaluation of the PH-4

4. Summary. Improvements should be made to reduce noise levels to meet military specifications (MIL-A-8806).

/s/ William C. Thrasher
/t/ WILLIAM C. THRASHER
2/Lt., MSC
Ass't Chief, Avn Fld Opns Div

1 Incl
as

NOISE LEVEL MEASUREMENTS-OCTAVE BAND ANALYSIS

DATA COLLECTION SHEET

Analyzed by Sgt. Parsons Date 1 August 1963

PH-4

| DOORS-ON | A | B | C | Center | Student | Air Speed | Mani-fold | RPM | Radius |
|---|---|---|---|---|---|---|---|---|---|
| Ground idle | 98 | 105 | 108 | | x | | 10.5" | 2200 | |
| Ground high power | 96 | 100 | 102 | | x | | 13.7" | 3200 | |
| Hover | 100 | 107 | 110 | | x | | 23.0" | 3200 | |
| Normal cruise | 100 | 104 | 107 | | x | | 24.0" | 3200 | |
| Maximum cruise | 105 | 109 | 113 | | x | | 24.0" | 3200 | |
| DOORS-OFF | | | | | | | | | |
| Ground idle | 94 | 104 | 109 | | x | | 10.5" | 2200 | |
| Ground high power | 101 | 107 | 109 | | x | | 13.7" | 3200 | |
| Hover | 103 | 107 | 110 | | x | | 23.0" | 3200 | |
| Normal cruise | 102 | 108 | 115 | | x | | 24.0" | 3200 | |
| Maximum cruise | 106 | 112 | 118 | | x | | 24.0" | 3200 | |
| EXT HIGH POWER | | | | | | | | | |
| 0 | 92 | 101 | 105 | | | | 13.7" | 3200 | 50' |
| 30 | 93 | 100 | 103 | | | | | | |
| 60 | 98 | 104 | 107 | | | | | | |
| 90 | 99 | 106 | 109 | | | | | | |
| 120 | 101 | 109 | 112 | | | | | | |
| 150 | 102 | 109 | 113 | | | | | | |
| 180 | 102 | 112 | 114 | | | | | | |
| HOVER | | | | | | | | | |
| 0 | 93 | 101 | 104 | | | | 23.0" | 3200 | 50' |
| 30 | 94 | 100 | 103 | | | | | | |
| 60 | 98 | 103 | 106 | | | | | | |
| 90 | 101 | 107 | 109 | | | | | | |
| 120 | 103 | 109 | 113 | | | | | | |
| 150 | 107 | 112 | 115 | | | | | | |
| 180 | 103 | 111 | 114 | | | | | | |

ANNEX A

PARAGRAPH B

HEADQUARTERS
UNITED STATES ARMY PRIMARY HELICOPTER SCHOOL
Fort Wolters, Mineral Wells, Texas

AKPWO-HS 27 August 1963

SUBJECT: Evaluation of Mission Suitability of the Prim ry Helicopter Trainer (Off-the-Shelf) USATECOM Project No. 4-3-1000-01-A

TO: President
US Army Aviation Test Board
Fort Rucker, Alabama

Attached hereto are reports of evaluation of mission suitability for the PH-1, PH-4, and PH-5 Helicopters.

/s/ J. E. Gonseth Jr
/t/ J. E. GONSETH JR
Colonel, Signal Corps
Commandant

3 Incl
1. PH-1
2. PH-4
3. PH-5

## PARAGRAPH B

## EVALUATION OF MISSION SUITABILITY

## OF THE PH-4 HELICOPTER

## AS CONDUCTED BY THE US ARMY PRIMARY HELICOPTER SCHOOL

1. Scope. Experienced primary flight instructors from the US Army Primary Helicopter School conducted primary flight training with qualified student officers with no previous flight experience and transition training for rated Army aviators with varied experience in observation helicopters. The helicopter was repeatedly flown through typical training missions with the students being required to perform maneuvers included in the approved flight syllabus of the US Army Primary Helicopter School, Fort Wolters, Texas.

2. Findings.

a. Hovering. The stiffness of cyclic and collective pitch controls contribute to pilot fatigue and is conducive to late control corrections by the pilot.

b. Normal Takeoff and Normal Approach. A heavy collective pitch created difficulty in adjusting and maintaining desired power settings. The center seating position of the student pilot places him behind the console which blocks forward visibility at approach termination.

c. Maximum Performance Takeoff and Steep Approach. The helicopter performed this maneuver in an acceptable manner, except the center seating position of the student pilot places him behind the console which blocks forward visibility at approach termination.

d. Running Takeoff and Landing. The helicopter performed this maneuver in an acceptable manner.

e. Hovering Autorotations. The helicopter performed this maneuver in an acceptable manner.

f. Autorotations. The helicopter performed this maneuver in an acceptable manner; however, the rate of descent in autorotation is higher than desired for a Primary Trainer. Visibility from the center seat is poor.

g. Simulated Forced Landings. The helicopter performed this maneuver in an acceptable manner; however, the rate of descent in autorotation is higher than desired for a Primary Trainer. Visibility from the center seat is poor.

h. Decelerations. The helicopter performed this maneuver in an acceptable manner.

i. Simulated anti-torque control failure. The helicopter performed this maneuver in an acceptable manner.

3. Comparison with Criteria for Evaluation of Mission Suitability of "Off-the-shelf" Primary Helicopter Trainers. A comparison of the characteristics of the helicopter with the Criteria for Evaluation follows:

| Criteria for Evaluation | Helicopter Meets Criteria | Remarks |
|---|---|---|
| Flight Controls (Cyclic, collective and anti-torque): Must have a rapid and positive response with no tendency to overshoot in response to corrections in powered and non-powered flight due to the general inability of the student pilot to treat any aircraft with the same finesse and care of a seasoned pilot. | YES | The PH-4 helicopter meets the flight control criteria with the exception of the stiffness in the cyclic and collective pitch controls. |
| Stability: Inherent stability in the vertical, longitudinal and lateral axis that will absorb power changes (power to non-power and non-power to power, intentional/inadvertent) with minimum corrective action required to regain positive control. | YES | |
| Power Reserve: Provide an adequate power reserve that will allow the instructor pilot to contain or recover from unusual | YES | |

| Criteria for Evaluation | Helicopter Meets Criteria | Remarks |
|---|---|---|
| situations induced by student errors. | | |
| Autorotative Characteristics: Rotor Mass and inertia adequate to allow for student error in autorotative landings. | YES | |
| Latitude for Student Error: Inherent flight characteristics that will allow a student to make an identifiable error and still have sufficient latitude for the student pilot and/or instructor pilot to make a recovery. No preflight or starting techniques that would demand detailed procedure or unsual knowledge on the part of the student pilot and instructor pilot. | YES | |
| Training Endurance Considerations: Adequate ventilation, heating and defrosting equipment. Ample shoulder room between instructor pilot and student and between collective and door. Comfortable seat cushions to allow four hours of flight without undue fatigue. | YES | The PH-4 helicopter meets the training endurance considerations with the exception of shoulder room between the IP and student. |
| Location of Controls: Trim controls if required on each cyclic stick. Any control locking or safety devices in sight and reach of the instructor pilot. | YES | |
| Ground Resonance: Must be free of ground resonance. | YES | |

4. Conclusion: The PH-4 helicopter is suitable for use as a Primary Helicopter Trainer.

PARAGRAPH C

BAAR-P 6 September 1963

SUBJECT: USABAAR's Evaluation of PH-4 Off-the-Shelf Primary Helicopter Trainer

TO: President
U. S. Army Aviation Test Board
ATTN: Off-the-Shelf Project Officer
Fort Rucker, Alabama

1. The following is USABAAR's evaluation of the PH-4 for the off-the-shelf primary helicopter trainer competition. The evaluation considered the categories of aviation safety and accident prevention in three primary categories. In each of these categories, USABAAR found the aircraft to be acceptable for its intended mission. However, there are certain deficiencies which will detract from its mission capability and should be considered by those responsible for selecting the winner of the competition. Categories considered are:

a. Operational Safety - This category considers those features of the aircraft and its operating characteristics that are considered to be conducive to accident causation and which may detract from the operator's ability to maintain safe flight at all times.

b. Maintenance Safety - This category considers maintenance design features of the aircraft contributing to accident causation. It includes those features of "Murphy's Law," ease of inspection, accessibility for component replacement, the pre-flight inspections imposed on the operator, etc.

c. Crashworthiness - This category considers design features of the aircraft that, in the event of a crash, provide protection to the occupants from injury. It also includes features of crash-fire worthiness.

2. Evaluation comments are as follows:

a. Operational Safety

(1) There are excess control forces on the collective pitch which would result in pilot fatigue.

(2) The tail boom "Pogo" stick is not substantial.

(3) The tail rotor has no guard extending beyond the blades which would prevent personnel from walking into them.

(4) The main skid shoes are not full length.

(5) There is insufficient leg room between the pilot's collective pitch control and the copilot's cyclic control. This causes interference with the controls.

(6) The cyclic control contacts the seat cushion.

(7) The instrument labels are not standardized, i.e., some are positioned on top of the instruments and some underneath. The labels should be embossed as well as painted.

(8) The heater air intake valve is located in close proximity to the engine exhaust which will allow fumes to enter the cockpit during downwind hovering.

(9) The manual cargo foot release is situated so that it could easily be inadvertently actuated.

b. Maintenance Safety

(1) Continuous read-out chip detectors are not provided in the engine or transmission systems.

(2) There are inadequate provisions for "step here" areas on which to stand while pre-flighting the rotor head.

c. Crashworthiness

(1) Shoulder harnesses with inertia reels have not been provided.

(2) There is no overhead protection for personnel in the event of a crash in which the aircraft turns over.

(3) The seat belt buckles are of a civilian design which is inadequate for Army standards.

3. If the above noted items are corrected by the manufacturer's proposal, they will no longer be considered discrepancies.

4. The following features are recognized as desirable and considered worthy of mention:

a. The number of post-crash fires of the basic PH-4 airframe construction has been negligible as evidenced by accident records on file in USABAAR.

b. The emergency exits and releases are well marked and suitable for quick egress.

c. The range of external vision from the cockpit is excellent.

/s/ Robert M. Hamilton
/t/ ROBERT M. HAMILTON
Colonel, Infantry
Director, USABAAR

## PARAGRAPH D

### Human Factors Evaluation of PH-4 Primary Trainer

1. Summary

1.1 The human factors design of the crew area of the PH-4 primary training helicopter was found to be adequate for mission accomplishment with the exception of the heating system which is considered unsatisfactory.

2. Detailed Considerations

2.1 The heating system is unsatisfactory due to the fact that it cannot be used during ground operations or while hovering. As a sizeable proportion of primary training consists of ground operation and hovering, the crew's winter comfort is sharply impeded by this deficiency.

2.2 The location of the attitude indicator and electrical system master switch adjacent to the lighting switches is undesirable. A guarded or lift-type safety switch should be used for these switches, and preferably, they should be separated to avoid the possibility of cutting off electrical power while intending to turn off the attitude indicator. This event would also turn off the lights required for finding the master switch itself, and at night could produce total lack of instrument information.

2.3 A cover over the attitude indicator is considered preferable to switching off the power to this instrument. When this instrument does not present correct attitude it is very distracting to both students and instructors who have established a scanning pattern including it. A complete blank is preferable to incorrect information.

/s/ Robert H. Wright
/t/ ROBERT H. WRIGHT, Ph. D.
Research Scientist

and

/s/ H. Alton Boyd, Jr.
/t/ H. ALTON BOYD, JR.
Research Associate

## UNIT C - COMPANY C MODEL PH-5

## SECTION ONE

## USAAVNTBD REPORT

A. Description of Materiel.

1. The PH-5 is a single-engine, three-place, side-by-side, two-bladed single main rotor and tail rotor type helicopter. Power is supplied by a Model TVO-435-B1A vertically-mounted, six-cylinder, opposed type air-cooled supercharged engine, which provides maximum rated power of 270 b.hp. at 3200 r.p.m. from sea level to 14,000 feet. Engine power is transmitted to the rotors through a double planetary reduction transmission. The main-rotor mast assembly is set into the transmission, which is bolted to the engine, making the complete assembly one rigid unit. Takeoff shaft connections extend from the transmission to drive the tail (antitorque) rotor.

2. Flight controls consist of cyclic, collective pitch, and antitorque control pedals. The collective and cyclic controls are power boosted with hydraulic cylinders which have a lock and load limiting feature.

3. The main rotor system consists of a two-bladed teetering rotor, blade grips, hub, and stabilizer bar. The all-metal blades have ten-pound weights installed in each tip which provide 50-percent higher rotor inertia than previous models. A two-bladed, all-metal, antitorque tail rotor mounted on a delta hinge provides directional control.

4. The helicopter center body section and tail boom are of a welded-tubular steel construction. The cockpit enclosure consists of a transparent, tinted, Plexiglas bubble. The internal cockpit width is five feet which allows sufficient space for the three-place seating. The cockpit door incorporates sliding windows with air deflectors for improved ventilation. Additional air circulation is provided by individually positioned soft rubber fans located on the left and right side of the center pedestal.

5. General dimensions of the helicopter submitted for test are listed below:

| | | |
|---|---|---|
| a. | Overall height | 9 feet 4 inches |
| b. | Overall length (main rotor tip to tail rotor tip) | 43 feet 3 inches |
| c. | Main rotor diameter | 37 feet 2 inches |
| d. | Fuselage width | 5 feet 5 inches |
| e. | Skid gear tread | 7 feet 6 inches |

B. Scope of Test. The test was conducted in the vicinity of Fort Rucker, Alabama, by USAAVNTBD project officers and USAPHS instructor personnel. The tests consisted of three phases: a 60-flying-hour test, a study of the manufacturer's technical proposals which described changes to configure the test helicopter to meet the stated requirements, and a comparison of the helicopter with the Model Specification and the Statement of Requirement. In addition, the US Army Board for Aviation Accident Research (USABAAR) evaluated the aviation safety aspect; the US Army Aviation Human Research Unit (USAAHUMRU) evaluated the human factors aspect; and the US Army Aeromedical Research Unit (USAARU) evaluated noise level, internal lighting, and heating and ventilation.

C. Tests.

1. Evaluation of Physical and Flight Characteristics, Performance, Mission Suitability, and Maintenance.

a. Physical Characteristics.

(1) Basic and Operating Weights. The helicopter was weighed as delivered with oil and trapped (unusable) fuel. To this weight (1900 pounds), the weight of electronic and auxiliary equipment required for Army use (146 pounds) was added, and the weight of currently installed equipment not required for Army use (73 pounds) was subtracted, resulting in a total estimated basic weight of 1973 pounds. The estimated mission operating weight was then computed by adding to the estimated basic weight the weight of fuel (342 pounds) and 400 pounds (instructor and student). Details follow:

| | |
|---|---|
| EMPTY WEIGHT as weighed (less ground-handling wheels) | 1900 lb. |

| | | |
|---|---|---|
| Weight of required equipment to be added: | | |
| Shoulder harness and inertia reel (2 each) | 6 lb. | |
| First-aid kit and fire extinguisher | 10 lb. | |
| AN/ARC-45 (UHF) | 27 lb. | |
| C-1611 interphone (2 each) | 4 lb. | |
| Attitude indicator (proposed) | 3 lb. | |
| Inverter (proposed) | 4 lb. | |
| MA-7 battery | 34 lb. | |
| Military upholstery (proposed) | 15 lb. | |
| Heater (proposed) | 43 lb. | |
| TOTAL ADDED | 146 lb. | 146 lb. |
| | | 2046 lb. |
| Weight of installed equipment to be removed: | | |
| Commercial radio | 8 lb. | |
| Commercial upholstery | 31 lb. | |
| Battery | 34 lb. | |
| TOTAL SUBTRACTED | 73 lb. | -73 lb. |
| TOTAL BASIC WEIGHT (estimated) | | 1973 lb. |
| Fuel | | 342 lb. |
| Instructor and student | | 400 lb. |
| MISSION OPERATING WEIGHT | | 2715 lb. |

| | |
|---|---|
| MISSION OPERATING WEIGHT (brought forward) | 2715 lb. |
| REMAINING AVAILABLE PAYLOAD | 235 lb. |
| MAXIMUM CERTIFICATED GROSS WEIGHT | 2950 lb. |

(2) Center-of-Gravity Travel. Control travel was sufficient to provide control at the extremes of allowable center-of-gravity (CG) position at maximum certificated and normal operating gross weights. The addition, removal, or relocation of ballast or aircraft components was not necessary for the helicopter to remain within CG limits when changes were made in loading of the helicopter with respect to fuel, instructor, and student.

(3) Ground Clearance. Ground clearance was sufficient for operation in unimproved areas; however, engine supercharger housing presents a fire hazard in tall grass. At normal rotor r.p.m., ground-to-main-rotor clearance was satisfactory with cyclic stick centered but did not meet specifications when cyclic was fully displaced.

(4) Ground-Handling Characteristics. Ground-handling characteristics of the helicopter, with removable wheels provided, were satisfactory.

(5) Suitability for Hoisting, Jacking, and Mooring. The helicopter was equipped with suitable hoisting and jacking hard points and had suitable locations on the structure for attachment of mooring lines.

(6) Suitability of External Power Receptacle. The helicopter was equipped with an external power receptacle that was compatible with Army APU's.

(7) Adequacy of Cockpit Configuration and Arrangement. The cockpit configuration and arrangement of the test helicopter were evaluated except for those items changed in the manufacturer's technical proposal. The cockpit configuration and arrangement were satisfactory except for the following:

(a) The location of the magnetic compass was undesirable in that it was not centrally located for view by the instructor pilot.

(b) The free air temperature gauge was located in a position that made it difficult to read from both student and instructor pilot stations.

(c) No provisions were made for quick-disconnect of the battery.

(d) Installed seat belts did not meet military specifications.

(8) Suitability of Internal Lighting. The USAARU evaluation (paragraph A, section two) is summarized as follows: "The cockpit and instrument panel illumination met the Model Specifications."

(9) Suitability of External Lighting.

(a) The position lights, located on the forward cross tubes of the landing skids, were satisfactory.

(b) The anti-collision rotating beacons installed on the helicopter were satisfactory.

(c) The landing light was adjustable from the ground and was satisfactory.

(10) Durability and Reliability. Durability and reliability could not be determined within the relatively short test time specified.

(11) Transportability. The helicopter is capable of being transported by C-123/C-130 type aircraft and by surface transport.

(12) Noise Level. The USAARU evaluation (paragraph A, section two) is summarized as follows: "Internal and external sound pressure levels met the Statement of Requirement. However, numerous internal measurements exceeded Military Specifications for acoustical noise levels in Army aircraft."

b. Flight Characteristics. The helicopter was flown at gross weights up to maximum certificated (2950 lb.). The following was determined:

(1) Stability. Stability was satisfactory. Momentary "hands-off" flight was possible for all but moderate-to-severe turbulent conditions.

(2) Controllability. Controllability was satisfactory. Flight characteristics were satisfactory with hydraulic boost turned off.

c. Performance. The helicopter was flown at FAA-certificated gross weight (2950 pounds) and estimated mission operating weight (2715 pounds) to determine whether it met the performance criteria stated in the Model Specification. The following was determined:

(1) The helicopter is capable of cruising at 65 knots true airspeed (TAS) at sea level.

(2) Endurance at 65 knots (TAS) was:

(a) 3.3 hours at 2950 pounds (maximum gross weight) at 4100 feet density altitude.

(b) 3.6 hours at 2715 pounds (mission operating weight) at 3800 feet density altitude.

(3) Hover-out-of-ground effect could be accomplished at a density altitude of 4400 feet which is equivalent to a pressure altitude of 1000 feet with an ambient temperature of 110°F. at maximum gross weight.

(4) The rates of climb under ICAO sea level standard day conditions at 45 knots (TAS) were:

(a) 850 feet per minute at 2950 pounds (maximum gross weight)

(b) 1060 feet per minute at 2715 pounds (mission operating weight)

The Model Specification required 1000 f.p.m. under these conditions.

(5) The autorotational performance was determined at 4400 feet density altitude (1000 feet pressure altitude, 110°F.) and at a true airspeed of 40 knots for maximum gross weight and for estimated mission operating weight. Tested under these conditions, the rates of descent were:

(a) 1540 feet per minute at 2950 pounds (maximum gross weight).

(b) 1560 feet per minute at 2715 pounds (mission operating weight).

(6) In autorotation under those conditions (paragraph (5) above) the helicopter regained normal rotor r.p.m. following a decay of rotor r.p.m. to the lower operating limit with an average of a 190-foot loss of altitude.

(7) The helicopter is not susceptible to ground resonance.

(8) The helicopter was capable of landing cross slope on 15-degree slopes with the right skid up slope. With the left skid up slope, there was insufficient left cyclic control for a 15-degree cross-slope landing.

d. Mission Suitability. This portion of the test was conducted by the USAPHS. Their report (paragraph B, section two) is summarized as follows:

"The PH-5 Helicopter is suitable for the training mission. The evaluation considered the areas of flight controls, stability, power reserve, autorotative characteristics, latitude for student error, training endurance, location of controls, and ground resonance. In each of these areas, USAPHS found the aircraft acceptable for its intended mission."

e. Maintenance.

(1) During the evaluation, the helicopter was maintained by the manufacturer's representative with military personnel provided for servicing, general assistance, and maintenance of records. The helicopter required only organizational maintenance. Maintenance requirements will not differ from those of Army helicopters presently in the Army inventory.

(2) The helicopter was easy to service and maintain.

(3) No components required replacement during the evaluation.

(4) Tools and ground support equipment normally found at the organizational level were adequate for organizational maintenance. Special tools are required for higher echelons of maintenance.

2. Evaluation of Manufacturer's Technical Proposal. The manufacturer's technical proposal to configure the test helicopter to meet the Model Specification was reviewed and the following was determined:

a. A combustion-type heater with 30,000-B.t.u. capacity was provided.

b. Inertia reels, which are considered necessary for the primary helicopter training mission, were not specified.

c. Floor- and cyclic-control-mounted radio-interphone keying switches were proposed for both student and instructor crew stations.

d. The electronic configuration was satisfactory.

e. Inverter proposed for the attitude indicator did not conform to appendix I of the Model Specification.

f. The USABAAR evaluation (paragraph C, section two) is summarized as follows:

"The evaluation considered the categories of operational safety, maintenance safety, and crashworthiness. In the categories of operational safety and maintenance safety, USABAAR found the aircraft to be acceptable for its intended mission.

"However, USABAAR found this aircraft unacceptable in the crashworthiness category. The post-crash fire potential of this aircraft appears to be even greater than that of other 'twin saddle fuel tank' Company B models."

g. The USAAHUMRU evaluation (paragraph D, section two) is summarized as follows:

"The human factors design of the PH-5 primary training helicopter was found to be adequate for mission accomplishment with the following exceptions:

"a. Lack of specification of a shoulder harness installation, and

"b. An arrangement of instruments which is considered below minimum acceptable standards."

3. Comparison with Model Specification and Statement of Requirement. In determining whether the PH-5 met the requirements of the Model Specification and Statement of Requirement, the characteristics of the helicopter as tested and an evaluation of the manufacturer's technical proposal were considered.

a. Comparison with Model Specification as Amended.

| Mod. Spec. Para. No. | Model Specification as Amended | PH-5 Meets Spec. | Remarks |
|---|---|---|---|
| 1. | SCOPE. | | |
| 1.1 | Scope. This detail specification covers the essential requirements for the design of a single engine primary helicopter trainer capable of performing the mission specified in 1.2. | | |
| 1.1.1 | Designation and General Description. | | |
| | Army Model Designation - Primary Helicopter Trainer (Army Model Number not yet assigned) | | |
| | Number of Crew - 1 Pilot | Yes | |
| | Number of Passengers - 1 Student | Yes | |
| | Crew and Passenger Seating Arrangement - Side by Side | Yes | |

| Mod. Spec. Para. No. | Model Specification as Amended | PH-5 Meets Spec. | Remarks |
|---|---|---|---|
| | Flight Controls - Dual | Yes | |
| | Type of Engine - Reciprocating | Yes | |
| | Main Rotor System - Single | Yes | |
| 1.2 | Mission. The primary Army mission for which this helicopter will be employed is training of military pilots in the basic operation and performance of a helicopter. Training will be accomplished under conditions to which Visual Flight Rules apply. | Yes | |
| 1.3 | Federal Aviation Agency Certification. The helicopter will have a Part 6 standard airworthiness certificate issued by the Federal Aviation Agency. | Yes | |
| 1.4 | Performance Information. Those items of performance stated as requirements herein which are not included in the FAA approved flight manual are subject to verification by the U. S. Army. | Yes | |
| 2. | APPLICABLE DOCUMENTS. | | |
| 2.1 | The documents applicable to this specification are those necessary to fulfill the requirements of paragraph | Yes | |

| Mod. Spec. Para. No. | Model Specification as Amended | PH-5 Meets Spec. | Remarks |
|---|---|---|---|
| | 1.3, Federal Aviation Agency Certification. | | |
| 3. | REQUIREMENTS. | | |
| 3.1 | Basic Weight. The basic weight of the helicopter will include all required installed equipment including the items of Paragraphs 3.7, 3.8.1.1, 3.8.1.2 and the Electronic Equipment as stated in Table E, Appendix I. | Yes | |
| 3.2 | Center of Gravity Travel. Addition, removal or relocation of ballast or aircraft components will not be necessary in order to maintain the CG within CG limits due to changes in loading of the helicopter with respect to fuel, pilot and student. | Yes | |
| 3.3 | Useful Load. The useful load of the helicopter will be sufficient for 400 lbs. in addition to the fuel and oil necessary to accomplish the 2 1/2 hour endurance mission specified in paragraph 3.4.1. | Yes | |
| 3.4 | Required Performance. | | |
| 3.4.1 | ICAO Sea Level Standard Day Performance (at certificated gross weight). | | |

| Mod. Spec. Para. No. | Model Specification as Amended | PH-5 Meets Spec. | Remarks |
|---|---|---|---|
| | Cruise Speed (Minimum) - 65 knots | Yes | |
| | Endurance (Minimum) - 2 1/2 hours at 65 knots cruise speed | Yes | |
| | Rate of Climb (Minimum) - 1000 ft. per minute | No | At maximum gross weight, rate of climb was 850 f.p.m., and at mission operating weight rate of climb was 1060 f.p.m. |
| 3.4.2 | Hovering Performance Requirement. At certificated gross weight the aircraft shall hover out of ground effect at 1000 ft. at 110°F. | Yes | |
| 3.4.3 | Autorotation Characteristics. (at certificated gross weight) | | |
| 3.4.3.1 | Normal Autorotation Speed. The manufacturer will designate a speed for normal autorotation not to exceed 45 knots. | Yes | |
| 3.4.3.2 | Rate of Descent. At the speed designated in 3.4.3.1 the helicopter will not exceed a stabilized autorotation rate of descent of 2200 feet per minute under conditions of 1000 ft. altitude and 110°F. | Yes | |

| Mod. Spec. Para. No. | Model Specification as Amended | PH-5 Meets Spec. | Remarks |
|---|---|---|---|
| 3.4.3.3 | Rotor R.P.M. Decay. In autorotation at the speed in 3.4.3.1 and conditions of 1000 ft. and 110°F., if rotor R.P.M. decays to the lower R.P.M. limit, the helicopter will be capable of regaining normal operating R.P.M. (as specified by the manufacturer) and with an altitude loss not to exceed 200 feet. | Yes | |
| 3.5 | Aircraft Structure. | | |
| 3.5.1 | Landing Gear. | | |
| 3.5.1.1 | Type Landing Gear. Skid type landing gear which will permit running take-offs and landings. | Yes | |
| 3.5.1.2 | Slope Landings. The landing gear will permit cross slope landings on slopes of 15°. | Yes | Insufficient cyclic control for left skid up slope. |
| 3.5.1.3 | Ground Handling. Ground handling wheels are required. Weight of the ground handling wheels will not be included in the weight empty if they are detachable. | Yes | |
| 3.5.1.4 | Hoisting, Jacking and Mooring. Provisions will be made for hoisting, jacking and mooring. | Yes | |
| 3.5.2 | Main Rotor Blades. | | |

| Mod. Spec. Para. No. | Model Specification as Amended | PH-5 Meets Spec. | Remarks |
|---|---|---|---|
| 3.5.2.1 | Blade Interchangeability. The main rotor blades will be individually interchangeable. | Yes | |
| 3.5.3 | Control Pedals. Both sets of directional control pedals of the aircraft will be adjustable. | Yes | |
| 3.5.4 | Operating Environment. | | |
| 3.5.4.1 | Aircraft Operation. The aircraft will be capable of operating in temperatures from 0°F. to +100°F. | Undetermined | Temperatures during test ranged from 75°F. to 95°F. |
| 3.5.4.2 | Cabin Heating. The aircraft will have a heating system which provides a minimum of 50°F. cabin temperature with 0°F. outside air temperature. This condition need only be satisfied with the engine operating. | Undetermined | 30,000-B.t.u. combustion heater was proposed. Due to temperature ranges, this test could not be conducted. |
| 3.6 | Fuel and Lubricants. The engine will operate on such fuel and lubricants which are now established as standard by the U. S. Army (Ref: MIL G-5572C dated 12 Jul 60 & MIL-L-22851 dated 30 Jun 61 & MIL-L-6082C dated 18 May 61). | Yes | |
| 3.7 | Instruments and Navigational Equipment. Flight instruments and lights for day and | Yes | |

| Mod. Spec. Para. No. | Model Specification as Amended | PH-5 Meets Spec. | Remarks |
|---|---|---|---|
| | night VFR conditions shall be furnished and installed by the contractor. | | |
| | An attitude indicator shall be provided as part of the basic aircraft instrumentation. | Yes | |
| 3.8 | Electrical. | | |
| 3.8.1 | Lighting. | | |
| 3.8.1.1 | Anti-Collision Light. The aircraft will have an anti-collision light. The light will be located to prevent reflection into the cockpit. | Yes | |
| 3.8.1.2 | Landing Light(s). The aircraft will be equipped with landing light(s) which will be adjustable. The landing light switch will be located on the pilot's cyclic or collective control. | Yes | |
| 3.8.2 | Power Receptacle. The aircraft will be equipped with an external power receptacle of an AN or AMS standard design. | Yes | |
| 3.8.3 | Switches and Auxiliary Controls. All switches and auxiliary controls necessary for flight and navigation will be accessible and within reach of the student pilot | Yes | |

| Mod. Spec. Para. No. | Model Specification as Amended | PH-5 Meets Spec. | Remarks |
|---|---|---|---|
| | and the instructor pilot. Switches and controls shall be operable in flight by personnel wearing winter flight clothing. Accessible floor mounted and cyclic control mounted radio-interphone switches will be provided for both student pilot and instructor. | | |
| 3.9 | Electronic Equipment. The aircraft will be equipped with the electronic equipment as indicated in Appendix I. | No | See appendix I below. |
| 3.10 | Safety Equipment. Seat belt and shoulder harness will be furnished for all occupants. | No | Seat belts and shoulder harnesses did not meet military specifications. |
| | Appendix I. | | |
| | Communication. | | |
| | UHF - AN/ARC-45, 1 ea. | Yes | GFE |
| | ICS - C-1611, 2 ea. | Yes | GFE |
| | Miscellaneous. | | |
| | Antenna - AT-450/ARC, 1 ea. | Yes | GFE |
| | Battery - Sonotone MA-7, 1 ea. | Yes | |

| Mod. Spec. Para. No. | Model Specification as Amended | PH-5 Meets Spec. | Remarks |
|---|---|---|---|
| | Inverter (If required either inverter listed will be a suitable substitute for standard equipment.) - Leland MIL-E-93-200 or Bendix 328-172-1, 1 ea. | No | Static inverter proposed. |

b. Comparison with Statement of Requirement. A comparison with the Statement of Requirement (reference 4) excluding those requirements covered by the Model Specification follows:

| Requirement | PH-5 Meets Requirement | Remarks |
|---|---|---|
| Size | | |
| It is desired that the external dimensions of the helicopter, less rotor, not exceed 8 feet in height, 23 feet in length, and 7 feet in width. | No | Helicopter height was 9.3 feet, length was 43.25 feet, and width was 7.5 feet. |
| With full cyclic movement, the rotor blade tip clearance above the ground level should not be less than 6 feet with rotors turning. | No | With cyclic centered and normal rotor r.p.m., ground-to-main-clearance was satisfactory. |
| A minimum rotor diameter consistent with good autorotative characteristics is desired. | Yes | |
| Structure and Design | | |
| The following will be required. Main rotor blades which are interchangeable, without retracking desirable. | Yes | |

| Requirement | PH-1 Meets Requirement | Remarks |
|---|---|---|
| If more than two main rotor blades, provisions should be provided for simple expeditious folding and unfolding. | N/A | |
| It shall be free from ground resonance. | Yes | |
| **Electrical** | | |
| The following are required. Lighting: adequate position, cockpit, anti-collision and landing lights for night flight. Position and anti-collision lights to be positioned to prevent reflection into cockpit; landing light to be adjustable. | Yes | |
| **Durability and Reliability.** | | |
| Engine and dynamic components should not be materially affected by dust, sand, moisture, etc., encountered in operation from unprepared areas. | Undetermined | |
| **Noise Level** | | |
| The lowest possible noise level is desired without use of a complex or elaborate muffler system or extension or heavy insulation. | Yes | Exceeded MIL-A-8806 in all areas (paragraph A, section two). |
| **Personnel Considerations** | | |
| No new personnel skills will be required. | Yes | Due to similarity of the helicopter to other helicopters in the Army inventory, |

| Requirement | PH-5 Meets Requirement | Remarks |
|---|---|---|
| | | no new skills will be required. |
| Training Considerations | | |
| No new training requirements will be generated. | Yes | No new training requirements for technical service schools are required. |
| No supporting training devices other than those on hand at the US Army training base are required. | Yes | |

D. Deficiencies and Shortcomings.

1. The following deficiencies were noted during the conduct of test:

| Deficiency | Suggested Corrective Action |
|---|---|
| a. Seat belts did not meet the military specification. | Provide seat belts designed in accordance with the military specification. |
| b. Shoulder harnesses and inertia reels were not provided. | Provide shoulder harnesses and inertia reels that meet the military specification. |
| c. Rate of climb did not meet the Model Specification for maximum gross weight. | Increase power available. |
| d. Crashworthiness was unsatisfactory. | Reduce post-crash fire potential. |

2. The following shortcomings were noted during conduct of test:

| Shortcomings | Suggested Corrective Action |
|---|---|
| a. Location of magnetic compass was unsatisfactory. | Relocate for easy reference by both student and instructor. |
| b. Location of free air temperature gauge was unsatisfactory. | Relocate for easy reference by both student and instructor. |
| c. No provisions were made for quick disconnect of the battery. | Provide quick disconnect for battery. |
| d. Ignition switch was located so that it was susceptible to accidental activation. | Provide protective shield for ignition switch. |
| e. Location of exhaust gas outlet and supercharger housing creates a danger of fire when operating in grassy areas. | Reduce danger of fire from exhaust gas outlet and supercharger housing. |
| f. Fuel-selector valve control connection located in tail boom behind the engine was susceptible to damage. | Relocate fuel-selector valve control connection to a position less susceptible to damage. |
| g. Magnetic chip detectors were not installed in the engine and transmission oil sumps. | Provide magnetic chip detectors. |
| h. Inverter proposed for attitude indicator did not conform to Model Specification. | Provide inverter which meets the Model Specification. |
| i. Heater operation was prohibited at airspeeds under 10 m.p.h. | Provide a heater capable of operation on the ground and at airspeeds under 10 m.p.h. |

## SECTION TWO

## Reports from Other Agencies on the PH-5

PARAGRAPH A

Aviation Field Operations Division
U. S. ARMY AEROMEDICAL RESEARCH UNIT
Fort Rucker, Alabama 36362

USAARU-FO 29 July 1963

NOISE EVALUATION OF THE PH-5

1. Methods and Equipment.

a. Due to the number of aircraft to be tested and the short time available for testing, the noise analysis was limited to the following:

"A" 24-55 db: sound level for speech interference.

"B" 55-85 db: sound level for noise survey.

"C" 85-140 db: sound pressure level, over-all frequency response.

b. A Sound-Level-Meter, General Radio, type 1551-C, was used for the noise measurement.

c. The test area, located at County Line Strip, is a pre-marked circle with a radius of 50 feet divided into $30^{o}$ segments.

2. Results. (See Annex A)

3. Discussion.

| | Doors On | Doors Off | MIL-A-8806 |
|---|---|---|---|
| Normal cruise | 103 | 113 | 106 |
| Maximum cruise | 104 | 116 | 113 |

a. Operation of this helicopter at maximum cruise with the doors off produced an excessive sound pressure level of 116 decibels. Variation of airspeed and relative wind direction demonstrated the fact that straight and level flight at speeds of 75 to 85 mph produced sufficient wind buffeting in the cockpit to record a decibel range of 116 to 120, which exceeds Table I MIL-A-8806.

b. Normal cruise with the doors off produced 113 decibels which exceeds Table IV MIL-A-8806.

c. There are no military specifications for external noise. Raw data is included for comparison purposes only.

4. Summary. Improvements should be made to reduce noise levels to meet military specifications (MIL-A-8806).

/s/ William C. Thrasher
/t/ WILLIAM C. THRASHER
2/Lt., MSC
Ass't Chief, Avn Fld Opns Div

1 Incl
as

NOISE LEVEL MEASUREMENTS-OCTAVE BAND ANALYSIS

DATA COLLECTION SHEET

Analyzed by Lt. Thrasher Date 16 July 1963

PH-5

| DOORS-ON | A | B | C | Center | Instructor | Air Speed | Manifold | RPM | Radius |
|---|---|---|---|---|---|---|---|---|---|
| Ground idle | 85 | 92 | 97 | | x | | 12.5" | 1700 | |
| Ground high power | 92 | 95 | 100 | | x | | 24" | 3200 | |
| Hover | 93 | 97 | 101 | | x | | 28" | 3200 | |
| Normal cruise | 94 | 98 | 103 | | x | 70 | 26" | 3100 | |
| Maximum cruise | 94 | 97 | 104 | | x | 80 | 27.2" | 3200 | |
| DOORS-OFF | | | | | | | | | |
| Ground idle | 87 | 97 | 101 | | x | | 12.5" | 1700 | |
| Ground high power | 97 | 104 | 109 | | x | | 24" | 3200 | |
| Hover | 99 | 104 | 107 | | x | | 28" | 3200 | |
| Normal cruise | 98 | 106 | 113 | | x | 70 | 26" | 3100 | |
| Maximum cruise | 99 | 107 | 116 | | x | 80 | 27.2" | 3200 | |
| EXT HIGH POWER | | | | | | | 24" | 3200 | 50' |
| 0 | 90 | 97 | 101 | 210° | 90 | 103 | 106 | | |
| 30 | 92 | 98 | 102 | 240° | 96 | 101 | 105 | | |
| 60 | 95 | 100 | 102 | 270° | 93 | 99 | 103 | | |
| 90 | 95 | 102 | 106 | 300° | 91 | 99 | 101 | | |
| 120 | 97 | 103 | 106 | 330° | 90 | 97 | 101 | | |
| 150 | 97 | 103 | 107 | | | | | | |
| 180 | 95 | 102 | 105 | | | | | | |
| HOVER | | | | | | | 28" | 3200 | 50' |
| 0 | 91 | 98 | 101 | 210° | 101 | 104 | 108 | | |
| 30 | 91 | 96 | 102 | 240° | 98 | 102 | 106 | | |
| 60 | 94 | 100 | 104 | 270° | 94 | 99 | 104 | | |
| 90 | 96 | 100 | 105 | 300° | 95 | 98 | 103 | | |
| 120 | 97 | 104 | 107 | 330° | 92 | 98 | 101 | | |
| 150 | 101 | 105 | 108 | | | | | | |
| 180 | 99 | 103 | 107 | | | | | | |

ANNEX A

Aviation Field Operations Division
U. S. ARMY AEROMEDICAL RESEARCH UNIT
Fort Rucker, Alabama 36362

USAARU-FO

29 July 1963

LIGHT EVALUATION OF THE PH-5

1. Methods and Equipment.

The evaluation consisted of in-flight analysis of the aircraft's lighting system under night conditions. Criteria for this evaluation were derived from U.S. Navy Specifications governing cockpit and instrument panel illumination modified to meet Army requirements.

2. Results. (See Annex A)

3. Discussion.

a. Instrument panel light reflections on the bubble are apparent when the lights are adjusted to the highest setting. With proper adjustment, all reflections from the instrument panel are eliminated.

b. During the twilight hours reflections from the light colored interior accessories were noted on the lower portions of the bubble.

c. The intensity of the auxiliary light or map light may be adjusted by rheostat and a lens selector gives the light the capability of white or standard red illumination.

4. Summary. The cockpit and instrument panel illumination of this aircraft is adequate for a primary trainer capable of performing night training missions.

1 Incl
as

/s/ William C. Thrasher
/t/ WILLIAM C. THRASHER
2/Lt., MSC
Ass't Chief, Avn Fld Opns Div

Aviation Field Operations Division
U. S. ARMY AEROMEDICAL RESEARCH UNIT
Fort Rucker, Alabama

## COCKPIT LIGHT STUDY

PH-5

1. Are all instruments adequately illuminated? Yes.
2. Are they illuminated uniformly? Yes Is there sufficient intensity? Yes
3. Is illumination controllable to very low intensities? Yes (Rheostat)
4. Are markings of instruments readable? Yes
5. Are all controls, instructions, and nameplates adequately illuminated? Yes
6. Are they illuminated uniformly? Yes Is there sufficient intensity? Yes
7. Is illumination controllable to very low intensities? Yes
8. Are markings on controls, instructions and nameplates readable? Yes
9. Is the intensity of lighting for some instruments and controls controlled separately? No
10. Is an auxiliary light provided? Yes Is light standard red? Yes
11. Is the power source independent of normal lighting circuit? Yes
12. Are there any sources of light which give other than standard red light? Yes (Note para 3c)
13. Are there any reflections in the windshield, windows, canopy or other reflecting surfaces which interfere with visibility inside or outside the cockpit? Yes (see para 3a & b)
14. Is there light leakage into the cockpit from other compartments? N/A

ANNEX A

15. Are spare lamps provided in sufficient quantity and easily accessible? No

16. Are all instruments, instructions, nameplates, and control markings readable in daylight? Yes

17. Can warning and caution lights be dimmed sufficiently for night operations? Yes

18. Are warning and caution lights of sufficient intensity for daylight use? Yes

19. Are warning and caution lights on the main dimming circuit? No

20. Is lighting provided in accordance with the aircraft detail specification? Yes

21. Is the light adequate for reading? Yes

22. Does the light cause glare to cockpit? Yes

23. Is there adequate general illumination for the compartment? Yes

24. Do any of the exterior lights provide glare in the cockpit? No

25. Is exterior lighting provided in accordance with FAA? Yes

Aviation Field Operations Division
U. S. ARMY AEROMEDICAL RESEARCH UNIT
Fort Rucker, Alabama 36362

USAARU-FO 29 July 1963

# REPORT ON PH-5 MODEL

1. Method of Testing.

a. The heating and ventilation evaluation of the PH-5 Model consisted of comparisons of outside air temperature and cockpit air temperature with the aircraft under all operating conditions. In conjunction with these checks, a carbon monoxide test was also made.

b. Equipment consisted of:

(1) Weston Aneroid Themometer, Model 2291.

(2) Mine Safety Appliance Company Carbon Monoxide Tester, Category No. DS-47133.

2. Results. (See Annex A)

3. Discussion:

a. The recommended maximum temperatures for clothed men not especially acclimatized are as follows:

(1) Resting in still air - 88°F.

(2) Resting, with some air movement (170 FPM air velocity)- 93°F.

(3) Moderate work, still air- 78°F.

Reference: Patty, Frank A., Industrial Hygiene & Toxicology (2d ed., Vol. 1; New York: Interscience Publishers Inc., 1958).

b. The PH-5 Model while operating with existing outside air temperatures in the 90°F. range meets the above listed requirements.

c. The largest percentage of carbon monoxide, 0.02%, was found with this aircraft at a hover with the doors on, windows closed, vents open. Maximum allowable concentration in a cockpit is 0.005% (50 ppm).

Reference: Air Force Manual No. 161-1, Flight Surgeon's Manual, Department of the Air Force.

d. Although this is considerably higher than the maximum allowable CO concentration, it would take approximately 80 minutes to develop a blood concentration of 10% CO, which is considered to be the upper limits. (These factors would not be constant--different weather conditions, i.e., wind, etc., would prevent maximum concentrations for extended periods of time). Approaching 25-30%, definite changes can occur which impair function.

Reference: Forbes, W. H., Sargent, F., and Roughton, F. J., "The Rate of Carbon Monoxide Uptake by Normal Man," American Journal of Physiology 143:594, 1945.

e. A heater was not installed on this aircraft.

/s/ J. C. Rothwell
/t/ J. C. ROTHWELL
Captain, MSC
Ass't Chief, Avn Fld Opns Div

1 Incl
as

HEATING AND VENTILATION EVALUATION OF OFF-THE-SHELF HELICOPTER TRAINERS

REPORT ON THE PH-5 MODEL

Analyzed by: S/Sgt L. P. Parsons Date: 16 July 1963

| | % CO | | TEMP | |
|---|---|---|---|---|
| | A/C | Out | A/C | Out |
| VENTILATION | | | | |
| On Ground | | | | |
| Doors Off (P) | .01 | - | 90 | 90 |
| Doors On - Window Open | .01 | - | 90 | 90 |
| Doors On - Window Closed, Vent Open | - | - | 100 | 90 |
| Doors On - Window Closed, Vent Closed | - | - | 98 | 90 |
| Hover | | | | |
| Doors Off (P) | .01 | - | 90 | 90 |
| Doors On - Window Open | .0025 | - | 98 | 90 |
| Doors On - Window Closed, Vent Open | .02 | - | 98 | 90 |
| Doors On - Window Closed, Vent Closed | .0025 | - | 100 | 90 |
| In-Flight | | | | |
| Doors Off (P) | .005 | - | 88 | 84 |
| Doors On - Window Open | .005 | - | 92 | 86 |
| Doors On - Window Closed, Vent Open | .005 | - | 94 | 86 |
| Doors On - Window Closed, Vent Closed | .005 | - | 102 | 86 |

HEATING*

*No heater installed

ANNEX A

PARAGRAPH B

HEADQUARTERS
UNITED STATES ARMY PRIMARY HELICOPTER SCHOOL
Fort Wolters, Mineral Wells, Texas

AKPWO-HS 27 August 1963

SUBJECT: Evaluation of Mission Suitability of the Primary Helicopter Trainer (Off-the-Shelf) USATECOM Project No. 4-3-1000-01-A

TO: President
US Army Aviation Test Board
Fort Rucker, Alabama

Attached hereto are reports of evaluation of mission suitability for the PH-1, PH-4, and PH-5 Helicopters.

/s/ J. E. Gonseth Jr
/t/ J. E. GONSETH JR
Colonel, Signal Corps
Commandant

3 Incl
1. PH-1
2. PH-4
3. PH-5

## PARAGRAPH B

## EVALUATION OF MISSION SUITABILITY

## OF THE PH-5 HELICOPTER

## AS CONDUCTED BY THE US ARMY PRIMARY HELICOPTER SCHOOL

1. Scope. Experienced primary flight instructors from the US Army Primary Helicopter School conducted primary flight training with qualified student officers with no previous flight experience and transition training for rated Army aviators with varied experience in observation helicopters. The helicopter was repeatedly flown through typical training missions with the students being required to perform maneuvers included in the approved flight syllabus of the US Army Primary Helicopter School, Fort Wolters, Texas.

2. Findings.

a. Hovering. The helicopter is difficult to hold at a constant altitude between six inches (6") to six feet (6') above the ground. Constant changes in collective pitch application are necessary in order to maintain the selected hover altitude. Delay in reaction to pitch changes causes an overshoot in pitch response and power control movements, which could result in a possible engine overboost condition.

b. Normal Takeoff and Normal Approach. Stability and power reserve on takeoff and approaches are excellent with the exception that utilization of the available power on approach termination requires prior planning in order to avoid engine overboost.

c. Maximum Performance Takeoff and Steep Approach. The utilization of available power on maximum performance takeoff and approach termination require prior planning in order to avoid an engine overboost condition.

d. Running Takeoff and Landing. The helicopter performed this maneuver in an acceptable manner.

e. Hovering Autorotations. The helicopter performed this maneuver in an acceptable manner.

f. Autorotations. The helicopter performed this maneuver in an acceptable manner with the exception that executing a power

recovery at fifty feet or below is marginal in that difficulty is experienced in maintaining proper r.p.m. and checking rate of descent without experiencing an engine overboost.

g. Simulated Forced Landings. The helicopter performed this maneuver in an acceptable manner with the exception that executing a power recovery at fifty feet or below is marginal in that difficulty is experienced in maintaining proper engine r.p.m. and checking rate of descent without experiencing an engine overboost.

h. Decelerations. The helicopter performed this maneuver in an acceptable manner.

i. Simulated Anti-torque Control Failure. The helicopter performed this maneuver in an acceptable manner.

3. Comparison with Criteria for Evaluation of Mission Suitability of "Off the Shelf" Primary Helicopter Trainers. A comparison of the characteristics of the helicopter with the Criteria for Evaluation follows:

| Criteria for Evaluation | Helicopter Meets Criteria | Remarks |
|---|---|---|
| Flight Controls: (Cyclic, collective, and anti-torque): Must have a rapid and positive response with no tendency to overshoot in response to corrections in powered and non-powered flight due to the general inability of the student pilot to treat any aircraft with the same finesse and care of a seasoned pilot. | YES | The PH-5 helicopter meets the flight control criteria with the exception of the collective pitch application in hovering flight. See par 2a. |
| Stability: Inherent stability in the vertical, longitudinal and lateral axis that will absorb power changes (Power to non-power and non-power to power, intentional/inadvertent) with minimum corrective action required to regain positive control. | YES | |

| Criteria for Evaluation | Helicopter Meets Criteria | Remarks |
|---|---|---|
| Power Reserve: Provide an adequate power reserve that will allow the instructor pilot to contain or recover from unusual situations induced by student errors. | YES | The PH-5 meets the power reserve criteria; however, a turbo supercharged engine is undesirable for use on a Primary Helicopter Trainer, See par 2a, b, c, f, and g. |
| Autorotative Characteristics: Rotor mass and inertia adequate to allow for student error in autorotative landings. | YES | |
| Latitude for Student Error: Inherent flight characteristics that will allow a student to make an identifiable error and still have sufficient latitude for the student pilot and/or instructor pilot to make a recovery. No preflight or starting techniques that would demand detailed procedure or unusual knowledge on the part of the student and instructor pilot. | YES | |
| Training Endurance Considerations: Adequate ventilation, heating and defrosting equipment. Ample shoulder room between instructor pilot and student and between collective and the door. Comfortable seat cushions to allow four hours of flight without undue fatigue. | YES | |
| Locations of Controls: Trim controls if required on each cyclic | YES | |

| Criteria for Evaluation | Helicopter Meets Criteria | Remarks |
|---|---|---|
| stick. Any control locking or safety devices in sight and reach of the instructor pilot. | | |
| Ground Resonance: Must be free from ground resonance. | YES | |

4. Conclusion: The PH-5 is suitable for use as a Primary Helicopter Trainer.

PARAGRAPH C

HEADQUARTERS
DEPARTMENT OF THE ARMY

Office of the Assistant Chief of Staff for Force Development
Board for Aviation Accident Research
Fort Rucker, Alabama

BAAR-P 6 September 1963

SUBJECT: Summary of USABAAR's Evaluation of PH-5 Off-the-Shelf Primary Helicopter Trainer

TO: President
U. S. Army Aviation Test Board
ATTN: Off-the-Shelf Project Officer
Fort Rucker, Alabama

1. The following is USABAAR's Evaluation of the PH-5 entry for the off-the-shelf primary helicopter trainer competition. The evaluation considered the categories of aviation safety and accident prevention in three primary categories. In each of these categories, USABAAR found the aircraft to be acceptable for its intended mission. However, there are certain deficiencies which will detract from it mission capability and should be considered by those responsible for selecting the winner of the competition. Categories considered are:

a. Operational Safety: This category considers those features of the aircraft and its operating characteristics that are considered to be conducive to accident causation and which may detract from the operator's ability to maintain safe flight at all times.

b. Maintenance Safety: This category considers maintenance design features of the aircraft contributing to accident causation. It includes those features of "Murphy's Law," ease of inspection, accessibility for component replacement, the preflight inspections imposed on the operator, etc.

c. Crashworthiness: This category considers design features of the aircraft that, in the event of a crash, provide protection to the occupants from injury. It also includes features of crash-fire worthiness.

BAAR-P 6 September 1963

SUBJECT: Summary of USABAAR's Evaluation of PH-5 Off-the-Shelf Primary Helicopter Trainer

2. Evaluation comments are as follows:

a. Operational Safety:

(1) The location of the engine supercharger housing and exhaust gases outlets are such that grass fires are a danger when operating in such areas.

(2) Vibrations at 70 MPH indicated airspeed and at or near gross loads, causes some difficulty in reading the instruments. When the airspeed is reduced to 60 MPH, read-out of the instruments improves.

(3) Rate of climb is very slow at maximum manifold pressure and RPM.

(4) The hydraulic boost control switch is located in the lower portion of the pedestal which makes it difficult to reach in the event of a failure in this system. A failure during nap-of-the-earth flying or at a hover requires the pilot to release the collective pitch control to activate this switch. USABAAR has on record two OH-13 accidents in which the hydraulic boost control failed during hovering and the pilot was unable or did not desire to release his control to shut the system off.

b. Maintenance Safety:

The fuel selector valve control connection located in the tail boom area, aft of the engine, can be damaged or malaligned quite easily when climbing the boom for rotor mast inspection.

c. Crashworthiness:

(1) The post-crash fire potential of this aircraft appears to be even greater than that of other twin tank Company C models. Increased fuel capacity, outboard location of the fuel tanks and extra ignition surface provided by the supercharger add to the potential. USABAAR considers this aircraft unacceptable in the crashworthiness category because of this.

(2) The energy absorption qualities of the seat cushions in this aircraft are inferior to those used in other Army aircraft.

(3) No inertia reel is provided for shoulder harnesses in the manufacturer's proposal.

3. The following features are recognized as desirable and considered worthy of mention:

a. Night lighting was found to be very good. No reflections were caused in the bubble from either the anti-collision lights, navigation lights, or instrument panel lights. The tinted bubble affords ease of eye strain during day and night operation.

b. Due to the high inertia main rotor blades, the aircraft is extremely easy to autorotate.

c. The stability of this aircraft is such that the aircraft can be flown hands-off for periods of 15 - 30 seconds.

/s/ Robert M. Hamilton
/t/ ROBERT M. HAMILTON
Colonel, Infantry
Director, USABAAR

PARAGRAPH D

U. S. ARMY AVIATION HUMAN RESEARCH UNIT
Fort Rucker, Alabama

11 September 1963

Human Factors Evaluation of PH-5 Primary Trainer

1. Summary

1.1 The human factors design of the PH-5 primary training helicopter was found to be adequate for mission accomplishment with the following exceptions.

a. Lack of a specification of a shoulder harness installation, and

b. an arrangement of instruments which is considered below minimum acceptable standards.

2. Detailed Considerations

2.1 Shoulder harness installations for instructor and student were not specified. This is probably an oversight but as the proposal stands it is considered a deficiency.

2.2 The proposed instrument arrangement is regarded as below minimum acceptable standards for a primary trainer.

2.2.1 The arrangement proposed indicates little if any consideration was given to the instrument scanning required of the student or instructor. The attitude indicator is located on the upper right side of the panel away from other flight instruments. The basic group of airspeed, altitude, rotor-engine RPM, and manifold pressure is located below a group of flight irrelevant instruments which are placed adjacent to the attitude indicator, and the heading indicator is mounted on the left door frame completely away from other instruments. Secondary indicators and controls such as radio, ICS, and ignition switches are placed in primary panel space rather than using this space for essential flight instruments. At a minimum the attitude indicator should be placed adjacent to the flight indicator group. Providing a heading indicator on or adjacent to the instrument console is con-

considered highly desirable. The instrument panel should be redesigned in accordance with the Army basic "T" instrument arrangement in primary panel space.

/s/ Robert H. Wright, Ph. D.
/t/ ROBERT H. WRIGHT, Ph. D
Research Scientist

## UNIT D - COMPANY C MODEL PH-6

## SECTION ONE

## USAAVNTBD REPORT

### A. Description of Materiel.

1. The PH-6 is a single-engine, three-place, side-by-side, two-bladed single main rotor and tail rotor type helicopter. Power is supplied by VO-435-AID vertically-mounted six-cylinder, opposed type air-cooled engine which provides maximum rated power at sea level of 240 b.hp. at 3200 r.p.m. Engine power is transmitted to the rotors through a double planetary reduction transmission. The main rotor mast assembly is set into the transmission, which is bolted to the engine, making the complete assembly one rigid unit. Takeoff shaft connections extend from the transmission to drive the tail (antitorque) rotor.

2. Flight controls consist of cyclic stick, collective pitch stick, and antitorque pedals. The cyclic control is power boosted with hydraulic cylinders which have lock and load limiting features.

3. The main rotor system consists of a two-bladed teetering rotor, blade grips, hub, and stabilizer bar. The all-metal blades are approximately two feet longer than previous models and provide 18 percent higher rotor inertia. A two-bladed, all-metal, antitorque tail rotor mounted on a delta hinge provides directional control.

4. The helicopter center body section and tail boom are of a welded tubular steel construction. The cockpit enclosure consists of a transparent, tinted, Plexiglas bubble. The internal width is 5 feet which allows sufficient space for the three-place seating. The cockpit door incorporates sliding windows with air deflectors for improved ventilation. Additional air circulation is provided by individually positioned soft rubber fans located on the left and right side of the center pedestal.

5. General dimensions of the helicopter submitted for test are listed below:

| | | |
|---|---|---|
| a. | Overall height | 9 feet 4 inches |
| b. | Overall length (main rotor tip to tail rotor tip) | 43 feet 3 inches |

c. Main rotor diameter 37 feet 2 inches

d. Fuselage width 5 feet 5 inches

e. Skid gear tread 7 feet 6 inches

B. Scope of Test. The test was conducted in the vicinity of Fort Rucker, Alabama, by USAAVNTBD project officers and USAPHS instructor personnel. The tests consisted of three phases: a 60-flying-hour test; a study of the manufacturer's technical proposals which described changes to configure the test helicopter to meet the stated requirements; and a comparison of the helicopter with Model Specification and the Statement of Requirement. In addition, the US Army Board for Aviation Accident Research (USABAAR) evaluated the aviation safety aspect; the US Army Aviation Human Research Unit (USAAHUMRU) evaluated the human factors aspect; and the US Army Aeromedical Research Unit (USAARU) evaluated noise level, internal lighting, and heating and ventilation.

C. Tests.

1. Evaluation of Physical and Flight Characteristics, Performance, Mission Suitability, and Maintenance.

a. Physical Characteristics.

(1) Basic and Operating Weights. The helicopter was weighed as delivered with oil and trapped (unusable) fuel. To this weight (1789 pounds), the weight of electronic and auxiliary equipment required for Army use (132 pounds) was added, and the weight of currently installed equipment not required for Army use (73 pounds) was subtracted, resulting in a total estimated basic weight of 1848 pounds. The estimated mission operating weight was then computed by adding to the estimated basic weight the weight of fuel (342 pounds) and 400 pounds (instructor and student). Details follow:

| | |
|---|---|
| EMPTY WEIGHT as weighed (less ground-handling wheels) | 1789 lb. |
| Weight of required equipment to be added: | |
| Shoulder harness and inertia reel (2 ea.) | 6 lb. |
| First-aid kit and fire extinguisher | 10 lb. |

| | | |
|---|---|---|
| AN/ARC-45 (UHF) | 27 lb. | |
| C-1611 interphone (2 ea.) | 4 lb. | |
| Attitude indicator (proposed) | 3 lb. | |
| Inverter | 4 lb. | |
| MA-7 battery | 34 lb. | |
| Military upholstery (proposed) | 18 lb. | |
| Heater (proposed) | 26 lb. | |
| TOTAL ADDED | 132 lb. | 132 lb. |
| | | 1921 lb. |
| Weight of installed equipment to be removed: | | |
| Commercial radio | 8 lb. | |
| Commercial upholstery | 31 lb. | |
| Battery | 34 lb. | |
| TOTAL SUBTRACTED | 73 lb. | -73 lb. |
| TOTAL BASIC WEIGHT (estimated) | | 1848 lb. |
| Fuel | | 342 lb. |
| Instructor and student | | 400 lb. |
| MISSION OPERATING WEIGHT | | 2590 lb. |
| REMAINING AVAILABLE PAYLOAD | | 260 lb. |
| MAXIMUM CERTIFICATED GROSS WEIGHT | | 2850 lb. |

(2) Center-of-Gravity Travel. Control travel was sufficient to provide control at the extremes of allowable center-of-gravity (CG) position at maximum certificated and normal operating gross weights. The addition, removal, or relocation of ballast or

aircraft components was not necessary for the helicopter to remain within CG limits when changes were made in loading of the helicopter with respect to fuel, instructor, and student.

(3) Ground Clearance. Ground clearance was sufficient for operation in unimproved areas. At normal operating r.p.m., ground-to-main-rotor clearance was satisfactory with cyclic stick centered but did not meet specifications when cyclic was fully displaced.

(4) Ground-Handling Characteristics. Ground-handling characteristics of the helicopter, with removable wheels provided, were satisfactory.

(5) Suitability for Hoisting, Jacking, and Mooring. The helicopter was equipped with suitable hoisting and jacking hard points and had suitable locations on the structure for attachment of mooring lines.

(6) Suitability of External Power Receptacle. The helicopter was equipped with an external power receptacle which was compatible with Army APU's.

(7) Adequacy of Cockpit Configuration and Arrangement. The cockpit configuration and arrangement of the test helicopter were evaluated except for those items changed in the manufacturer's technical proposal. The cockpit configuration and arrangement were found to be satisfactory except for the following:

(a) The location of the magnetic compass was undesirable in that it was not centrally located for view by the instructor pilot.

(b) The free air temperature gauge was located in a position that made it difficult to read from both student and instructor pilot stations.

(c) No provisions were made for quick-disconnect of the battery.

(d) Installed seat belts did not meet military specification.

(8) Suitability of Internal Lighting. The USAARU evaluation (paragraph A, section two) is summarized as follows: "The cockpit and instrument panel illumination of this aircraft and the technical proposal submitted met the Model Specification."

(9) Suitability of External Lighting. External lighting was satisfactory and met the Model Specification.

(10) Durability and Reliability. Durability and reliability could not be determined within the relatively short test time specified.

(11) Transportability. The helicopter is capable of being transported by C-123/130 type aircraft and by surface transport.

(12) Noise Level. The USAARU evaluation (paragraph A, section two) is summarized as follows: "Internal and external sound pressure levels met the Statement of Requirement; however, numerous internal measurements exceeded the Military Specification for acoustical noise levels in Army aircraft."

b. Flight Characteristics. The helicopter was flown at gross weights up to the maximum certificated (2850 pounds). The following was determined:

(1) Stability. The stability of the helicopter was satisfactory. Momentary hands-off cruising flight was possible for all but moderate-to-severe turbulent conditions.

(2) Controllability. Controllability was satisfactory. Flight characteristics were satisfactory with hydraulic boost turned off.

c. Performance. The helicopter was flown at gross weights up to the maximum certificated (2850 pounds) and estimated mission operating weight (2590 pounds) to determine whether it met the performance criteria stated in the Model Specification. The following was determined:

(1) The helicopter was capable of cruising at 65 knots true airspeed (TAS) at sea level.

(2) Endurance at 65 knots (TAS) was:

(a) 3.3 hours at 2850 pounds at 4200 feet density altitude (maximum gross weight).

(b) 3.5 hours at 2590 pounds at 3800 feet density altitude (mission operating weight).

(3) Hover-out-of-ground effect was accomplished at a density altitude of 4400 feet which is equivalent to a pressure altitude of 1000 feet with an ambient temperature of 110°F. at mission operating weight (2590 lb.). Hover-out-of-ground effect could not be accomplished at maximum gross weight (2850 lb.).

(4) The rates of climb under ICAO sea level standard day conditions at 48 knots (TAS) were:

(a) 750 feet per minute at 2850 pounds.

(b) 875 feet per minute at 2590 pounds.

(5) The autorotational performance was determined at 4400 feet density altitude (1000 feet pressure altitude at 110°F.) and at a true airspeed of 37 knots. Tested under these conditions, rates of descent were:

(a) 1800 feet per minute at 2850 pounds.

(b) 1930 feet per minute at 2590 pounds.

(6) In autorotation under those conditions (paragraph (5) above), the helicopter regained normal rotor r.p.m. following a decay of rotor r.p.m. to the lower operating limit with an average of 150-foot loss of altitude.

(7) The helicopter was capable of landing cross slope on 15-degree slopes with right landing skid up slope. There was insufficient left cyclic control for 15-degree cross slope landings with left skid up slope.

(8) The helicopter was not susceptible to ground resonance.

d. Mission Suitability. This portion of the test was conducted by the USAPHS. Their report (paragraph B, section two) is summarized as follows:

"The evaluation considered the areas of flight controls, stability, power reserve, autorotative characteristics, latitude for student error, training endurance, location of controls and ground resonance. In each of these areas the United States Army Primary Helicopter School found the aircraft acceptable for its intended mission."

e. Maintenance.

(1) During the evaluation, the helicopter was maintained by the manufacturer's representative with military personnel provided for servicing, general assistance, and maintenance of records. The helicopter required only organizational maintenance. Maintenance requirements will not differ from those of Army helicopters presently in the Army inventory.

(2) Engine operation on non-standard Army aviation fuel (80/87 octane) and standard Army lubricants was trouble free.

(3) The helicopter was easy to service and maintain.

(4) Replacement of components was not required.

(5) Tools and ground-support equipment normally found at the organizational level were adequate for organizational maintenance. Special tools are required for higher echelons of maintenance.

2. Evaluation of Manufacturer's Technical Proposal. The manufacturer's technical proposal to configure the test helicopter to meet Model Specification was reviewed and the following was determined:

a. The muff-type heater was unsatisfactory as it could not be used at speeds below 10 m.p.h.

b. Required shoulder harnesses with inertia reels were not specified.

c. Floor- and cyclic-control-mounted radio-interphone keying switches were proposed for both student and instructor crew stations.

d. An attitude indicator was proposed.

e. The electronic configuration was satisfactory.

f. Inverter proposed for the attitude indicator did not conform to appendix I of the Model Specification.

g. The USABAAR evaluation (paragraph C, section two) is summarized as follows:

"(a) The evaluation considered the categories of Operational Safety, Maintenance Safety, and Crashworthiness. In the

categories of Operational Safety and Maintenance Safety, USABAAR found the aircraft to be acceptable for its intended mission.

"(b) However, USABAAR found this aircraft unacceptable in the crashworthiness category. The post-crash fire potential appears to be even greater than that of other 'twin saddle fuel tank' Company C model (see appended complete report for these discrepancies)."

h. The USAAHUMRU evaluation (paragraph D, section two) is summarized as follows:

"The human factors design of the PH-6 primary training helicopter was found to be adequate for mission accomplishment with the following exceptions:

"(a) The heating system is considered unsatisfactory.

"(b) Lack of a specification of a shoulder harness installation, and

"(c) An arrangement of instruments which is considered below minimum acceptable standards."

3. Comparison with Model Specification and Statement of Requirement. In determining whether the PH-6 met the requirements of the Model Specification and Statement of Requirement, the characteristics of the helicopter as tested and an evaluation of the manufacturer's technical proposal were considered.

a. Comparison with Model Specification as Amended.

| Mod. Spec. Para. No. | Model Specification As Amended | PH-6 Meets Spec. | Remarks |
|---|---|---|---|
| 1 | SCOPE | | |
| 1.1 | Scope. This detail specification covers the essential requirements for the design | | |

| Mod. Spec. Para. No. | Model Specification As Amended | PH-6 Meets Spec. | Remarks |
|---|---|---|---|
| | of a single-engine primary helicopter trainer capable of performing the mission specified in 1.2. | | |
| 1.1.1 | Designation and General Description. | | |
| | Army Model Designation - Primary Helicopter Trainer (Army model number not yet assigned. | | |
| | Number of crew - 1 pilot (instructor) | Yes | |
| | Number of passengers - 1 student | Yes | |
| | Crew and passenger seating arrangement - side by side | Yes | |
| | Flight controls - dual | Yes | |
| | Type of engine - reciprocating | Yes | |
| | Main rotor system - single | Yes | |
| 1.2 | Mission. The primary Army mission for which this helicopter will be employed is training of military pilots in the basic operation and performance of a helicopter. Training will be accomplished under conditions to which Visual Flight Rules apply. | | |

| Mod. Spec. Para. No. | Model Specification As Amended | PH-6 Meets Spec. | Remarks |
|---|---|---|---|
| 1.3 | Federal Aviation Agency Certification. The helicopter will have a part 6 standard airworthiness certificate issued by the Federal Aviation Agency. | Yes | |
| 1.4 | Performance Information. Those items of performance stated as requirements herein which are not included in the FAA approved flight manual are subject to verification by the US Army. | Yes | |
| 2. | APPLICABLE DOCUMENTS. | | |
| 2.1 | The documents applicable to this specification are those necessary to fulfill the requirements of paragraph 1.3, Federal Aviation Agency Certification. | Yes | |
| 3. | REQUIREMENTS. | | |
| 3.1 | Basic Weight. The basic weight of the helicopter will include all required installed equipment including the items of paragraphs 3.7, 3.8.1.1, 3.8.1.2, and the electronic equipment as stated in Table E, Appendix I. | Yes | |
| 3.2 | Center-of-Gravity Travel. Addition, removal or relocation of ballast or aircraft | Yes | |

| Mod. Spec. Para No. | Model Specification As Amended | PH-6 Meets Spec. | Remarks |
|---|---|---|---|
| | components will not be necessary in order to maintain the CG limits due to changes in loading of the helicopter with respect to fuel, pilot and student. | | |
| 3.3 | Useful Load. The useful load of the helicopter will be sufficient for 400 pounds in addition to the fuel and oil necessary to accomplish the 2 1/2-hour endurance mission specified in paragraph 3.4.1. | Yes | |
| 3.4 | Required Performance. | | |
| 3.4.1 | ICAO Sea Level Standard Day Performance (at certificated gross weight). | | |
| | Cruise speed (minimum) - 65 knots. | Yes | |
| | Endurance (minimum) - 2 1/2-hours at 65 knots cruise speed. | Yes | |
| | Rate of climb (minimum) - 1000 feet per minute. | No | 750 feet per minute at 2850 lb. 875 feet per minute at 2590 lb. |

| Mod. Spec. Para No. | Model Specification As Amended | PH-6 Meets Spec. | Remarks |
|---|---|---|---|
| 3.4.2 | Hovering Performance Requirement. At certificated gross weight the aircraft shall hover out of ground effect at 1000 feet at 110°F. | No | Helicopter hovered at 4400 feet density altitude which is equivalent to 1000 feet pressure altitude at 110°F. at mission operating weight (2590 lb). |
| 3.4.3 | Autorotational Characteristics. (at certificated gross weight). | | |
| 3.4.3.1 | Normal Autorotation Speed. The manufacturer will designate a speed for normal autorotation not to exceed 45 knots. | Yes | |
| 3.4.3.2 | Rate of Descent. At the autorotative speed designated in 3.4.3.1, the helicopter will not exceed a stabilized autorotational rate of descent of 2200 feet per minute under conditions of 1000 feet altitude and 110°F. | Yes | |
| 3.4.3.3 | Rotor R.P.M. Decay. In autorotation at the speed in 3.4.3.1, and conditions of 1000 feet and 110°F., if rotor r.p.m. decays to the lower rotor r.p.m. limit, the helicopter will be | Yes | |

| Mod. Spec. Para No. | Model Specification As Amended | PH-6 Meets Spec. | Remarks |
|---|---|---|---|
| | capable of regaining normal operating r.p.m. (as specified by manufacturer) and with an altitude loss not to exceed 200 feet. | | |
| 3.5 | Aircraft Structure. | | |
| 3.5.1 | Landing Gear. | | |
| 3.5.1.1 | Type Landing Gear. Skid type landing gear which will permit running takeoffs and landings. | Yes | |
| 3.5.1.2 | Slope Landings. The landing gear will permit cross slope landings on slopes of 15°. | Yes | Insufficient cyclic control for left skid up slope. |
| 3.5.1.3 | Ground Handling. Ground handling wheels are required. Weight of the ground handling wheels will not be included in the empty weight if they are detachable. | Yes | |
| 3.5.1.4 | Hoisting, Jacking, and Mooring. Provisions will be made for hoisting, jacking, and mooring. | Yes | |
| 3.5.2 | Main Rotor Blades. | | |

| Mod. Spec. Para No. | Model Specification As Amended | PH-6 Meets Spec. | Remarks |
|---|---|---|---|
| 3.5.2.1 | Blade Interchangeability. The main rotor blades will be individually interchangeable. | Yes | |
| 3.5.3 | Control Pedals. Both sets of directional control pedals of the aircraft will be adjustable. | Yes | |
| 3.5.4 | Operating Environment. | | |
| 3.5.4.1 | Aircraft Operation. The aircraft will be capable of operating in temperatures from 0°F. to +100°F. | Undetermined | Temperatures during test ranged from 75°F. to 95°F. |
| 3.5.4.2 | Cabin Heating. The aircraft will have a heating system which provides a minimum of 50°F. cabin temperature with 0°F. outside air temperature. This condition need only be satisfied with the engine operating. | Undetermined | Heater was placarded prohibiting operation at speeds under 10 m.p.h. Due to temperature ranges, this test could not be conducted. |
| 3.6 | Fuel and Lubricants. The engine will operate on such fuel and lubricants which are now established as standard by the US Army (reference MIL-G-5572C, dated 12 July and MIL-L-22851, dated 30 June 61, and MIL-L-6082C, dated 18 May 61.) | No | Engine operated satisfactorily on 80/87 octane fuel. |

| Mod. Spec. Para. No. | Model Specification As Amended | PH-6 Meets Spec. | Remarks |
|---|---|---|---|
| 3.7 | Instruments and Navigational Equipment. Flight instruments and lights for day and night VFR conditions shall be furnished and installed by the contractor. An attitude indicator shall be provided as part of the basic aircraft instrumentation. | Yes | |
| 3.8 | Electrical. | | |
| 3.8.1 | Lighting. | | |
| 3.8.1.1 | Anti-Collision Light. The aircraft will have an anti-collision light. The light will be located to prevent reflection into the cockpit. | Yes | |
| 3.8.1.2 | Landing Light(s). The aircraft will be equipped with landing light(s) which will be adjustable. The landing light switch will be located on the pilot's cyclic or collective control. | Yes | |
| 3.8.2 | Power Receptacle. The aircraft will be equipped with an external power receptacle of an AN or AMS standard design. | Yes | |

| Mod. Spec. Para No. | Model Specification As Amended | PH-6 Meets Spec. | Remarks |
|---|---|---|---|
| 3.8.3 | Switches and Auxiliary Controls. All switches and auxiliary controls necessary for flight and navigation will be accessible and within reach of the student pilot and the instructor pilot. Switches and controls shall be operable in flight by personnel wearing winter flight clothing. Accessible floor mounted and cyclic control mounted radio-interphone switches will be provided for both student pilot and instructor. | Yes | |
| 3.9 | Electronic Equipment. The aircraft will be equipped with the electronic equipment as indicated in appendix I. | No | See Appendix I below. |
| 3.10 | Safety Equipment. Seat belt and shoulder harness will be furnished for all occupants. | No | Seat belts did not meet the Military Specification and shoulder harnesses were not furnished or proposed. |
| | APPENDIX I | | |
| | Communications | | |
| | UHF-AN/ARC-45, (1 ea) | Yes | GFE |

| Mod. Spec. Para. No. | Model Specification As Amended | PH-6 Meets Spec. | Remarks |
|---|---|---|---|
| | ICS C-1611, (2 ea.) | Yes | GFE |
| | Miscellaneous | | |
| | Antenna - AT-450/ARC, (1 ea.) | Yes | GFE |
| | Battery-Sonotone, MA-7 | Yes | |
| | Inverter-Leland MIL-E-93-200, Bendix 328-172-1. (If required, either inverter listed will be a suitable substitute for standard equipment.) | No | Static inverter proposed. |

b. Comparison with Statement of Requirement. A comparison with the Statement of Requirement (reference 4) excluding those requirements covered by the Model Specification follows:

| Requirement | PH-6 Meets Requirement | Remarks |
|---|---|---|
| Size | | |
| It is desired that the external dimensions of the helicopter, less rotor, not exceed 8 feet in height, 23 feet in length, and 7 feet in width. | No | Helicopter length 32.3 feet, width 9.5 feet, and height 9.3 feet. |
| With full cyclic movement, the rotor blade tip clearance above the ground level should not be less than 6 feet with rotors turning. | No | With cyclic control centered and normal rotor r.p.m., ground-to-main-rotor clearance was satisfactory. |

| Requirement | Helicopter Meets Requirement | Remarks |
|---|---|---|
| A minimum rotor diameter consistent with good auto-rotative characteristics is desired. | Yes | |
| **Structure and Design** | | |
| The following will be required: Main rotor blades which are interchangeable, without re-tracking desirable. | Yes | |
| If more than two main rotor blades, provisions should be provided for simple expeditious folding and unfolding. | N/A | |
| It shall be free from ground resonance. | Yes | |
| Suitable seat belt and shoulder harness for both student pilot and instructor. | No | Seat belts did not meet the military specification and shoulder harnesses with inertia reels were not specified in technical proposal. |
| **Electrical** | | |
| The following are required: Lighting; adequate position, cock-pit, anti-collision and landing lights for night flight. | Yes | |

| Requirement | PH-6 Meets Requirement | Remarks |
|---|---|---|
| Position and anti-collision lights to be positioned to prevent reflection into cockpit; landing light to be adjustable. | | |
| Durability and Reliability | | |
| Engine and dynamic components should not be materially affected by dust, sand, moisture, etc., encountered in operation from unprepared areas. | Undetermined | |
| Noise Level | | |
| The lowest possible noise level is desired without use of a complex or elaborate muffler system or extension or heavy insulation. | Yes | Exceeded MIL-A-8806 in all areas. (Reference paragraph A, section two.) |
| Personnel Considerations | | |
| No new personnel skills will be required. | Yes | Due to similarity of the helicopter to other helicopters in the Army inventory, no new skills will be required. |
| Training Considerations | | |
| No new training requirements will be generated. | Yes | No new training requirements for technical service schools are required. |

| Requirement | PH-6 Meets Requirement | Remarks |
|---|---|---|
| No supporting training devices other than those on hand at the US Army training base are required. | Yes | |

D. Deficiencies and Shortcomings.

1. The following deficiencies were noted during the conduct of the test:

| Deficiencies | Suggested Corrective Action |
|---|---|
| a. Seat belts did not meet the military specification. | Provide seat belts designed in accordance with the military specification. |
| b. Shoulder harnesses and inertia reels were not provided. | Provide shoulder harnesses and inertia reels that meet the military specification. |
| c. Rate of climb did not meet the Model Specification for maximum gross weight or mission operating weight. | Increase power available. |
| d. Helicopter could not hover OGE at 4400 feet density altitude at maximum gross weight. | Increase power available. |
| e. Crashworthiness was unsatisfactory. | Reduce post-crash fire potential. |

2. The following shortcomings were noted during conduct of the test:

| Shortcomings | Suggested Corrective Action |
|---|---|
| a. Location of magnetic compass was unsatisfactory. | Relocate for easy reference by both pilot and instructor. |

| Shortcomings | Suggested Corrective Action |
| --- | --- |
| b. Location of free-air temperature gauge was unsatisfactory. | Relocate for easy reference by both the instructor and student. |
| c. No provisions were made for quick disconnect of battery. | Provide quick disconnect for battery. |
| d. Inverter proposed for attitude indicator does not conform to Model Specification. | Provide inverter which meets the Model Specification. |
| e. Heater operation was prohibited at airspeeds under 10 m.p.h. | Provide a heater capable of operation on the ground and at airspeeds under 10 m.p.h. |

## SECTION TWO

### Reports from Other Agencies on the PH-6

PARAGRAPH A

Aviation Field Operations Division
U. S. ARMY AEROMEDICAL RESEARCH UNIT
Fort Rucker, Alabama 36362

USAARU-FO 21 August 1963

LIGHT EVALUATION OF THE PH-6

1. Methods and Equipment.

The evaluation consisted of in-flight analysis of the aircraft's lighting system under night conditions. Criteria for this evaluation were derived from U. S. Navy Specifications governing cockpit and instrument panel illumination modified to meet Army requirements.

2. Results. (See Annex A)

3. Discussion.

a. Instrument panel light reflections of the bubble are apparent when the lights are adjusted to the highest setting. With proper adjustment, all reflections from the instrument panel are eliminated.

b. During the twilight hours reflections from the light colored interior accessories were noted on the lower portions of the bubble.

c. The intensity of the auxiliary light or map light may be adjusted by rheostat and a lens selector gives the light the capability of white or standard red illumination.

4. Summary. The cockpit and instrument panel illumination of this aircraft is adequate for a primary trainer capable of performing night training missions.

/s/ William C. Thrasher
/t/ WILLIAM C. THRASHER
2/Lt., MSC
Ass't Chief, Avn Fld Opns Div

1 Incl
as

Aviation Field Operations Division
U. S. ARMY AEROMEDICAL RESEARCH UNIT
Fort Rucker, Alabama

COCKPIT LIGHT STUDY
PH-6

1. Are all instruments adequately illuminated? Yes

2. Are they illuminated uniformly? Yes Is there sufficient intensity? Yes

3. Is illumination controllable to very low intensities? Yes (Rheostat)

4. Are markings of instruments readable? Yes

5. Are all controls, instructions, and nameplates adequately illuminated? Yes

6. Are they illuminated uniformly? Yes Is there sufficient intensity? Yes

7. Is illumination controllable to very low intensities? Yes

8. Are markings on controls, instructions and nameplates readable? Yes

9. Is the intensity of lighting for some instruments and controls controlled separately? No

10. Is an auxiliary light provided? Yes Is light standard red? Yes

11. Is the power source independent of normal lighting circuit? Yes

12. Are there any sources of light which give other than standard red light? Yes (Note para 3c)

13. Are there any reflections in the windshield, windows, canopy or other reflecting surfaces which interfere with visibility inside or outside the cockpit? Yes (see para 3a & b)

ANNEX A

14. Is there light leakage into the cockpit from other compartments? N/A

15. Are spare lamps provided in sufficient quantity and easily accessible? N/A

16. Are all instruments, instructions, nameplates, and control markings readable in daylight? Yes

17. Can warning and caution lights be dimmed sufficiently for night operations? Yes

18. Are warning and caution lights of sufficient intensity for daylight use? Yes

19. Are warning and caution lights on the main dimming circuit? No

20. Is lighting provided in accordance with the aircraft detail specification? Yes

21. Is the light adequate for reading? Yes

22. Does the light cause glare to cockpit? No

23. Is there adequate general illumination for the compartment? Yes

24. Do any of the exterior lights provide glare in the cockpit? No

25. Is exterior lighting provided in accordance with FAA? Yes

Aviation Field Operations Division
U. S. ARMY AEROMEDICAL RESEARCH UNIT
Fort Rucker, Alabama 36362

USAARU-FO 21 August 1963

REPORT ON PH-6

1. Method of Testing.

a. The heating and ventilation evaluation of the PH-6 consisted of comparisons of outside air temperature and cockpit air temperature with the aircraft under all operating conditions. In conjunction with these checks, a carbon monoxide test was also made.

b. Equipment consisted of:

(1) Weston Aneroid Thermometer Model 2291.

(2) Mine Safety Appliance Company Carbon Monoxide Tester, Category No. DS-47133.

2. Results. (See Annex A)

3. Discussion:

a. The recommended maximum temperatures for clothed men not especially acclimatized are as follows:

(1) Resting in still air- 88°F.

(2) Resting, with some air movement (170 FPM air velocity)- 93°F.

(3) Moderate work, still air- 78°F.

Reference: Patty, Frank A., Industrial Hygiene & Toxicology (2d ed., Vol. 1; New York: Interscience Publishers Inc., 1958).

b. The PH-6 while operating with existing outside air temperatures in the 90°F. range meets the above listed requirements.

c. The largest percentage of carbon monoxide, 0.005 was found with this aircraft at a hover and at ground idle with doors off. This meets the maximum allowable concentration in a cockpit of 0.005% (50 ppm).

Reference: Air Force Manual No. 161-1, Flight Surgeon's Manual, Department of the Air Force.

d. Although this is considerably higher than the maximum allowable CO concentration, it would take approximately 80 minutes to develop a blood concentration of 10% CO, which is considered to be the upper limits. (These factors would not be constant--different weather conditions, i.e., wind, etc., would prevent maximum concentrations for extended periods of time.) Approaching 25-30%, definite changes can occur which impair function.

Reference: Forbes, W. H., Sargent, F., and Roughton, F. J., "The Rate of Carbon Monoxide Uptake by Normal Man," American Journal of Physiology 143:594, 1945.

e. A heater was not installed on this aircraft.

/s/ William C. Thrasher
/t/ W. C. THRASHER
2/Lt., MSC
Ass't Fld Opns Div

1 Incl
as

HEATING AND VENTILATION EVALUATION OF OFF-THE-SHELF
HELICOPTER TRAINERS
PH-6

Analyzed by Lt Thrasher Date 19 Aug 63

| | %CO | | Temp | | Humidity | |
|---|---|---|---|---|---|---|
| | A/C | Out | A/C | Out | A/C | Out |
| VENTILATION | | | | | | |
| On Ground | | | | | | |
| Doors Off (P) | .005 | | 90 | | 90 | |
| Doors On - Window Open | 0 | | 90 | | 90 | |
| Doors On - Window Closed, Vent Open | | | 100 | | 90 | |
| Doors On - Window Closed, Vent Closed | 0 | | 98 | | 90 | |
| Hover | | | | | | |
| Doors Off (P) | .005 | | 90 | | 90 | |
| Doors On - Window Open | 0 | | 98 | | 90 | |
| Doors On - Window Closed, Vent Open | | | 98 | | 90 | |
| Doors On - Window Closed, Vent Closed | | | 100 | | 90 | |
| In-Flight | | | | | | |
| Doors Off (P) | 0 | | 88 | | 84 | |
| Doors On - Window Open | 0 | | 92 | | 86 | |
| Doors On - Window Closed, Vent Open | | | 94 | | 86 | |
| Doors On - Window Closed, Vent Closed | 0 | | 102 | | 86 | |
| HEATING | | | | | | |
| On Ground, Engine at operating RPM, doors, vents and windows closed | | | | | | |
| Heater "Off" | | | | | | |
| Heater "On" | | | | | | |

Aviation Field Operations Division
U. S. ARMY AEROMEDICAL RESEARCH UNIT
Fort Rucker, Alabama 36362

USAARU-FO 21 August 1963

# NOISE EVALUATION OF THE PH-6

1. Methods and Equipment.

a. Due to the number of aircraft to be tested and the short time available for testing, the noise analysis was limited to the following:

"A" 24-55 db: sound level for speech interference.

"B" 55-85 db: sound level for noise survey.

"C" 85-140 db: sound pressure level, over-all frequency response.

b. A Sound-Level-Meter, General Radio, type 1551-C, was used for the noise measurement.

c. The test area, located at County Line Strip, is a pre-marked circle with a radius of 50 feet divided into $30^{o}$ segments.

2. Results. (See Annex A)

3. Discussion.

| | Doors On | Doors Off | MIL-A-8806 |
|---|---|---|---|
| Normal Cruise | 107 | 110 | 106 |
| Maximum Cruise | 109 | 114 | 113 |

a. Operation of this helicopter at maximum cruise with the doors off produced a sound pressure level of 114 decibels which exceeds Table I, MIL-A-8806.

b. Normal cruise with the doors on and off produced sound pressure levels of 107 and 110 decibels respectively which exceeds Table IV, MIL-A-8806.

c. There are no military specifications for external noise. Raw data is included for comparison purposes only.

4. Summary. Improvements should be made to reduce noise levels to meet military specifications (MIL-A-8806).

/s/ William C. Thrasher
/t/ WILLIAM C. THRASHER
2/Lt, MSC
Ass't Chief, Avn Fld Opns Div

1 Incl
as

NOISE LEVEL MEASUREMENTS-OCTAVE BAND ANALYSIS
DATA COLLECTION SHEET

Analyzed by Lt Thrasher and Sp Basel Date 19 Aug 63

PH-6

| DOORS-ON | A | B | C | Center | Student | Air Speed | Mani-fold | RPM | Radius |
|---|---|---|---|---|---|---|---|---|---|
| Ground idle | 89 | 98 | 103 | | | | 13" | 2200 | |
| Ground high power | 91 | 96 | 100 | | | | 16 | 3200 | |
| Hover | 92 | 97 | 100 | | | | 26 | 3200 | |
| Normal cruise | 93 | 98 | 107 | | | 80 | 24 | 3200 | |
| Maximum cruise | 95 | 100 | 109 | | | 100 | 26.5 | 3200 | |
| DOORS-OFF | | | | | | | | | |
| Ground idle | 92 | 103 | 108 | | | | 13 | 2200 | |
| Ground high power | 95 | 100 | 104 | | | | 16 | 3200 | |
| Hover | 96 | 99 | 105 | | | | 26 | 3200 | |
| Normal cruise | 94 | 102 | 110 | | | 80 | 24 | 3200 | |
| Maximum cruise | 97 | 104 | 114 | | | 100 | 26.5 | 3200 | |
| EXT HIGH POWER | | | | | | | 16" | 3200 | 50' |
| 0 | 89 | 96 | 99 | | | | | | |
| 30 | 91 | 96 | 97 | | | | | | |
| 60 | 93 | 97 | 99 | | | | | | |
| 90 | 96 | 98 | 101 | | | | | | |
| 120 | 96 | 101 | 103 | | | | | | |
| 150 | 98 | 102 | 105 | | | | | | |
| 180 | 96 | 103 | 106 | | | | | | |
| HOVER | | | | | | | 26" | 3200 | 50' |
| 0 | 89 | 92 | 99 | | | | | | |
| 30 | 92 | 96 | 102 | | | | | | |
| 60 | 94 | 98 | 103 | | | | | | |
| 90 | 99 | 103 | 106 | | | | | | |
| 120 | 103 | 106 | 109 | | | | | | |
| 150 | 103 | 107 | | | | | | | |
| 180 | 102 | 108 | 111 | | | | | | |

PARAGRAPH B

HEADQUARTERS
UNITED STATES ARMY PRIMARY HELICOPTER SCHOOL
Fort Wolters, Mineral Wells, Texas

AKPWO-HS 30 September 1963

SUBJECT: Evaluation of Mission Suitability of the Primary Helicopter Trainer (Off the Shelf) USATECOM Project No. 4-3-1000-01-A

TO: President
US Army Aviation Test Board
Fort Rucker, Alabama

Attached hereto are reports of evaluation of mission suitability for the PH-6, PH-7, and PH-9 Helicopters.

/s/ J. E. Gonseth, Jr
/t/ J. E. GONSETH, JR.
Colonel, Signal Corps
Commandant

3 Incls
1. PH-6
2. PH-7
3. PH-9

## PARAGRAPH B

## EVALUATION OF MISSION SUITABILITY

## OF THE

## PH-6 HELICOPTER AS CONDUCTED BY THE

## UNITED STATES ARMY PRIMARY HELICOPTER SCHOOL

1. Scope. Experienced primary flight instructors from the US Army Primary Helicopter School conducted primary flight training with qualified student officers with no previous flight experience and transition training for rated Army aviators with varied experience in observation helicopters. The helicopter was repeatedly flown through typical training missions with the students being required to perform maneuvers included in the approved flight syllabus of the US Army Primary Helicopter School, Fort Wolters, Texas.

2. Findings.

a. Hovering. The helicopter performed this maneuver in an acceptable manner.

b. Normal Take-Off and Normal Approach. The helicopter performed this maneuver in an acceptable manner.

c. Maximum Performance Take-Off and Steep Approach. The helicopter performed this maneuver in an acceptable manner.

d. Running Take-Off and Landing. The helicopter performed this maneuver in an acceptable manner.

e. Hovering Autorotations. The helicopter performed this maneuver in an acceptable manner.

f. Autorotations. The helicopter performed this maneuver in an acceptable manner.

g. Simulated Forced Landings. The helicopter performed this maneuver in an acceptable manner.

h. Decelerations. The helicopter performed this maneuver in an acceptable manner.

i. Simulated Anti-Torque Control Failure. The helicopter performed this maneuver in an acceptable manner.

j. General.

(1) The force required to increase and decrease collective pitch during powered flight is such that the many power and pitch changes necessary during primary flight training are very fatiguing to the student pilot and detract from the desired precision.

(2) The cyclic stick grip is too high to allow a comfortable "arm-on-thigh" relaxed position during flight.

3. Comparison with Criteria for Evaluation of Mission Suitability of "Off the Shelf" Primary Helicopter Trainers. A comparison of the characteristics of the helicopter with the Criteria for Evaluation follows:

| Criteria for Evaluation | Helicopter Meets Criteria | Remarks |
|---|---|---|
| Flight Controls (cyclic, collective and anti-torque): Must have a rapid and positive response with no tendency to overshoot in response to corrections in powered and non-powered flight due to the general inability of the student pilot to treat any aircraft with the same finesse and care of a seasoned pilot. | YES | |
| Stability: Inherent stability in the vertical, longitudinal and lateral axis that will absorb power changes (power to non-power and non-power to power, intentional/inadvertent) with minimum corrective action required to regain positive control. | YES | |
| Power Reserve: Provide an adequate power reserve that will allow the | YES | |

| Criteria for Evaluation | Helicopter Meets Criteria | Remarks |
|---|---|---|
| instructor pilot to contain or recover from unusual situations induced by student errors. | | |
| Autorotative Characteristics: Rotor mass and inertia adequate to allow for student error in autorotative landings. | YES | |
| Latitude for Student Error: Inherent flight characteristics that will allow a student to make an identifiable error and still have sufficient latitude for the student pilot and/or instructor pilot to make a recovery. No preflight or starting techniques that would demand detailed procedure or unusual knowledge on the part of the student pilot and instructor pilot. | YES | |
| Training Endurance Considerations: Adequate ventilation, heating and defrosting equipment. Ample shoulder room between instructor pilot and student and between collective pitch stick and the door. Comfortable seat cushions to allow four hours of flight without undue fatigue. | YES | |
| Location of Controls: Trim controls if required on each cyclic stick. Any control locking or safety devices in sight and reach of the instructor pilot. | YES | |
| Ground Resonance: Must be free from ground resonance. | YES | |

4. Conclusions. The PH-6 Helicopter is suitable for use as a Primary Helicopter Trainer.

PARAGRAPH C

BAAR-P 3 September 1963

SUBJECT: USABAAR's Evaluation of PH-6 Off-the-Shelf Primary Helicopter Trainer

TO: President
U.S.A. Aviation Test Board
ATTN: Off-the-Shelf Project Officer
Fort Rucker, Alabama

1. The following is USABAAR's Evaluation of the PH-6 for the off-the-shelf primary helicopter trainer competition. The evaluation considered the categories of aviation safety and accident prevention in three primary categories. USABAAR found the aircraft to be acceptable for its intended mission. However, there are certain deficiencies which will detract from its mission capability and should be considered by those responsible for selecting the winner of the competition. Categories considered are:

a. Operational Safety: This category considers those features of the aircraft and its operating characteristics, that are considered to be conducive to accident causation and which may detract from the operator's ability to maintain safe flight at all times.

b. Maintenance Safety: This category considers maintenance design features of the aircraft contributing to accident causation. It includes those features of "Murphy's Law," ease of inspection, accessibility for component replacement, the preflight inspections imposed on the operator, etc.

c. Crashworthiness: This category considers design features of the aircraft that, in the event of a crash, provide protection from injury to the occupants. It also includes features of crash-fire worthiness.

2. Evaluation comments are as follows:

SUBJECT: USABAAR's Evaluation of PH-6 Off-the-Shelf Primary Helicopter Trainer

a. Operation Safety:

(1) The collective pitch stick "grip" is of smooth texture on the surface. This should be a knurled or rough surface to preclude slippage.

(2) The hydraulic boost control switch is located in the lower portion of the pedestal which makes it difficult to reach in the event of a failure of the system. A failure during nap-of-the-earth flying, or at a hover requires the pilot to release the collective pitch control to activate this switch.

b. Maintenance Safety:

(1) The fuel selector valve control connection located in the tail boom area, aft of the engine, can be damaged or malaligned quite easily when climbing the boom for rotor mast inspections.

(2) Fittings which require lubrication are used throughout when others (lubrication free) are available and are more suited to Army aviation maintenance requirements.

c. Crashworthiness:

(1) The seat understructure does not utilize available space and materials to best advantage in energy absorption in the event of high vertical and longitudinal crash forces.

(2) The post crash fire potential of this aircraft appears to be even greater than that of other twin tank models. Increased fuel capacity of the fuel tanks add to this potential. USABAAR considers this aircraft unacceptable because of the fuel tank's post crash fire potential.

(3) The roll over protection provided in the cockpit is nil. A roll over bar of some type should be provided.

3. The following features are recognized as desirable and considered worthy of mention:

BAAR-P 3 September 1963

SUBJECT: USABAAR's Evaluation of PH-6 Off-the-Shelf Primary Helicopter Trainer

a. Night lighting was found to be very good. No reflections were caused in the bubble from either the anti-collision lights, navigation lights, or instrument panel lights. The tinted bubble affords ease of eye strain during day and night operations.

b. The increase in inertia of the main rotor blades makes autorotation much easier in comparison to helicopters already in the Army inventory.

c. The "hands off" flight stability of this helicopter is very good.

/s/ Robert M. Hamilton
/t/ ROBERT M. HAMILTON
Colonel, Infantry
Director, USABAAR

PARAGRAPH D

U. S. ARMY AVIATION HUMAN RESEARCH UNIT
Fort Rucker, Alabama

21 August 1963

Human Factors Evaluation of PH-6 Primary Trainer

1. Summary

1.1 The human factors design of the PH-6 primary training helicopter was found to be adequate for mission accomplishment with the following exceptions.

a. The heating system is considered unsatisfactory.

b. Lack of a specification of a shoulder harness installation, and

c. An arrangement of instruments which is considered below minimum acceptable standards.

2. Detailed Considerations

2.1 The heating system is unsatisfactory due to the fact that it cannot be used during ground operations or while hovering. As a sizeable proportion of primary training consists of ground operation and hovering, the crew's winter comfort is sharply impeded by this deficiency.

2.2 Shoulder harness installations for instructor and student were not specified. This is probably an oversight, but as the proposal stands it is considered a deficiency.

2.3 The proposed instrument arrangement is regarded as below minimum acceptable standards for a primary trainer.

2.3.1 The arrangement proposed indicates little if any consideration was given to the instrument scanning required of the student or instructor. The attitude indicator is located on the upper right side of the panel away from other flight instruments. The basic group of airspeed, attitude, rotor-engine r.p.m., and manifold pressure is located below a group of flight irrelevant instruments which are placed adjacent to the attitude indicator, and the heading indicator is mounted on the left door

frame completely away from other instruments. Secondary indicators and controls such as radio, ICS, and ignition switches are placed in primary panel space rather than using this space for essential flight instruments. At a minimum the attitude indicator should be placed adjacent to the flight indicator group. Providing a heading indicator on or adjacent to the instrument console is considered highly desirable. The instrument panel should be redesigned in accordance with the Army basic "T" instrument arrangement in primary panel space.

/s/ Robert H. Wright, Ph.D.
/t/ ROBERT H. WRIGHT, Ph.D
Research Scientist

## UNIT E - COMPANY B MODEL PH-7

## SECTION ONE

## USAAVNTBD REPORT

A. Description of Materiel.

1. The PH-7 is a single engine, three-place, side-by-side, two-bladed single main rotor and tail rotor type helicopter. Power is supplied by a VO540-C1A vertically-mounted six-cylinder, opposed type, air-cooled non-supercharged engine, which has a maximum rated power at sea level of 305 b.hp. at 3200 r.p.m. Engine power is transmitted to the rotors through a double planetary reduction transmission. The main rotor mast assembly is set into the transmission, which is bolted to the engine, making the complete assembly one rigid unit. Takeoff shaft connections extend from the transmission to drive the tail (antitorque) rotor. The helicopter tested was not Federal Aviation Agency (FAA) certificated and had not been issued a type inspection report (TIR). However, the model designation was type certificated on 18 September 1963.

2. Flight controls consist of cyclic stick, collective pitch stick, and antitorque pedals. The collective and cyclic controls are power boosted with hydraulic cylinders which have a lock and load-limiting feature. A cyclic trim system is provided which incorporates a spring in series with a magnetic brake which is normally engaged to react the spring force. A button on the cyclic grip is used to re-trim the cyclic stick at a desired position. A two-axis stability augmentation system (SAS) is installed and provides limited authority (approximately 10 percent) roll and pitch stabilization.

3. The main rotor system is a two-bladed, teetering, underslung rotor. The rotor cuffs which retain the blades are attached to the hub through a set of four angular contact ball bearings and a needle bearing which allows the blades to cycle about the feathering axis. The all-metal blades have a constant chord. A two-bladed, all-metal, antitorque tail rotor mounted on flapping hinges provides directional control.

4. The helicopter basic body section and tail boom are of all-metal stressed-skin construction with a tinted Plexiglas bubble. A skid-type landing gear with removable ground-handling wheels is used.

AD-A033 205 ARMY AVIATION TEST BOARD FORT RUCKER ALA F/G 1/3
MILITARY POTENTIAL TEST OF COMMERCIAL 'OFF THE SHELF' HELICOPTE--ETC(U)
JAN 64 W S DAVIS, H G SMITH

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3 OF 4
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5. General dimensions of the PH-7 are listed below:

| | | |
|---|---|---|
| a. | Overall height | 10 feet 2 inches |
| b. | Overall length (main rotor tip to tail rotor tip) | 40 feet 6 inches |
| c. | Rotor diameter | 35 feet |
| d. | Fuselage width | 4 feet 11 inches |
| e. | Skid gear tread | 7 feet 6 inches |

B. Scope of Test. The test was conducted in the vicinity of Fort Rucker, Alabama, by USAAVNTBD project officers and USAPHS instructor personnel. The test consisted of three phases: a 60-flying-hour test; a study of the manufacturer's technical proposals which describe changes to configure the test helicopter to meet the stated requirements; and a comparison of the helicopter with the Model Specification and the Statement of Requirement. In addition, the US Army Board for Aviation Accident Research (USABAAR) evaluated the aviation safety aspect; the US Army Aviation Human Research Unit (USAAHUMRU) evaluated the human factors aspect; and the US Army Aeromedical Research Unit (USAARU) evaluated noise level, internal lighting, and heating and ventilation.

C. Tests.

1. Evaluation of Physical and Flight Characteristics, Performance, Mission Suitability, and Maintenance.

a. Physical Characteristics.

(1) Basic and Operating Weights. The helicopter was weighed as delivered with oil and trapped (unusable) fuel. To this weight (1880 pounds), the weight of electronic auxiliary equipment required for Army use (92 pounds) was added, and the weight of currently installed equipment not required for Army use (43 pounds) was subtracted, resulting in a total estimated basic weight of 1929 pounds. The estimated mission operating weight was then computed by adding to the estimated basic weight the weight of fuel (276 pounds) and 400 pounds (instructor and student). Details follow:

| | | |
|---|---|---|
| EMPTY WEIGHT as weighed (less ground-handling wheels) | | 1880 lb. |
| Required equipment to be added: | | |
| Shoulder harness and inertia reel (2 ea.) | 6 lb. | |
| First-aid kit and fire extinguisher | 10 lb. | |
| AN/ARC-45 (UHF) | 27 lb. | |
| C-1611 interphone (2 ea.) | 4 lb. | |
| Attitude Indicator (proposed) | 3 lb. | |
| Inverter (proposed) | 8 lb. | |
| MA-7 Battery | 34 lb. | |
| TOTAL ADDED | 92 lb. | 92 lb. |
| | | 1972 lb. |
| Installed equipment to be removed: | | |
| Commercial radio | 15 lb. | |
| Battery | 28 lb. | |
| TOTAL SUBTRACTED | 43 lb. | -43 lb. |
| TOTAL BASIC WEIGHT (estimated) | | 1929 lb. |
| Fuel | | 276 lb. |
| Instructor and Student | | 400 lb. |
| MISSION OPERATING WEIGHT | | 2605 lb. |
| REMAINING AVAILABLE PAYLOAD | | 495 lb. |
| MAXIMUM CERTIFICATED GROSS WEIGHT | | 3100 lb. |

(2) Center-of-Gravity Travel. Control travel was sufficient to provide control at the extremes of allowable center-of-gravity (CG) position at maximum certificated and normal operating gross weights. The addition, removal, or relocation of ballast or aircraft components was not necessary for the helicopter to remain within CG limits when changes were made in loading of the helicopter with respect to fuel, instructor, and student.

(3) Ground Clearance. Ground clearance was sufficient for operation in unimproved areas. At normal operating r.p.m., ground-to-main-rotor clearance was satisfactory with cyclic stick centered, but did not meet specifications when cyclic was fully displaced.

(4) Ground-Handling Characteristics. Ground-handling characteristics of the helicopter, with removable wheels provided, were satisfactory.

(5) Suitability for Hoisting, Jacking, and Mooring. The helicopter was equipped with suitable jacking hard points and had suitable locations on the structure for attachment of mooring lines. Special hoisting straps are required for hoisting the helicopter.

(6) Suitability of External Power Receptacle. The helicopter was equipped with an external power receptacle which was compatible with Army APU's.

(7) Adequacy of Cockpit Configuration and Arrangement. The cockpit configuration and arrangement of the test helicopter were evaluated except for those items changed in the manufacturer's technical proposal. The cockpit configuration and arrangement were found to be satisfactory except for the following:

(a) The center-left seating arrangement was unsatisfactory because of the close proximity of the student's collective control to the instructor's position.

(b) Engine power could be decreased when throttle friction was applied.

(c) The manifold pressure bleed-air control was located behind the left instrument console ash tray and was inaccessible.

(d) Installed seat belts did not meet military specification.

(e) The heater installed was unsatisfactory because it could not be used during hovering flight.

(8) Suitability of Internal Lighting. The USAARU evaluation (paragraph A, section two) is summarized as follows: "The cockpit and instrument panel illumination of this aircraft met model specifications."

(9) Suitability of External Lighting. External lighting was satisfactory and met the Model Specification.

(10) Durability and Reliability. Durability and reliability could not be determined within the relatively short test time specified.

(11) Transportability. The helicopter is capable of being transported by C-123/C-130 type aircraft and surface transport.

(12) Noise Level. The USAARU evaluation (paragraph A, section two) is summarized as follows: "Internal and external sound pressure levels met model specifications. However, numerous internal measurements exceed the military specifications for acoustical noise levels in Army aircraft."

b. Flight Characteristics. The helicopter was flown at gross weights up to the maximum certificated (3100 pounds). The following was determined:

(1) Stability. Stability was satisfactory. "Hands-off" cruising flight was possible for all but moderate-to-severe turbulent conditions with stability augmentation system (SAS) on. Overall stability of the helicopter was unsatisfactory with the SAS off.

(2) Controllability. Controllability was satisfactory. Control response was positive and of a rate suitable for primary helicopter training with SAS on. Control travel was adequate to provide the necessary controllability for maneuvers performed in primary helicopter training. Controllability was unsatisfactory with SAS off.

(3) Boost Off Flight. With hydraulic boost turned off, a definite lateral instability problem existed. Because of this instability,

hover flight was extremely tiring and dangerous from the standpoint of controllability. In cruise flight with the hydraulic boost turned off, control forces were acceptable. Autorotations with the hydraulic boost turned off were not attempted because of the lateral instability problem.

c. Performance. The helicopter was flown at the maximum certificated gross weight (3100 lb.) and estimated mission operating weight (2605 lb) to determine whether it met the performance criteria stated in the Model Specification. The following was determined:

(1) The helicopter was capable of cruising at 65 knots true airspeed (TAS) at sea level.

(2) Endurance at 65 knots (TAS) was:

(a) 2.6 hours at 3100 pounds at 4300 feet density altitude.

(b) 3.0 hours at 2605 pounds at 3900 feet density altitude.

(3) Hover-out-of-ground effect was accomplished at a density altitude of 4400 feet which is equivalent to a pressure altitude of 1000 feet with an ambient temperature of 110° F.

(4) The rates of climb under ICAO sea level standard day conditions at 35 knots (TAS) were:

(a) 1110 feet per minute at 3100 pounds.

(b) 1350 feet per minute at 2605 pounds.

(5) The autorotational performance was determined at 4400 feet density altitude (1000 feet pressure altitude at 110°F.) and at a true air speed of 37 knots for maximum gross weight. Tested under these conditions, the following rates of descent were determined:

(a) 1680 feet per minute at 3100 pounds.

(b) 1640 feet per minute at 2605 pounds.

(6) In autorotation under those conditions (paragraph (5) above), the helicopter regained normal rotor r.p.m. following a

decay of rotor r.p.m. to the lower operating limit with an average of a 190-foot loss of altitude.

(7) The helicopter is not susceptible to ground resonance.

(8) The helicopter was capable of landing cross slope on 15-degree slopes.

d. Mission Suitability. This portion of the test was conducted by the USAPHS. Their report (paragraph B, section two) is summarized as follows: "The evaluation considered the areas of flight controls, stability, power reserve, autorotative characteristics, latitude for student error, training endurance, location of controls and ground resonance. In each of these areas, USAPHS found the aircraft acceptable for its intended mission."

e. Maintenance.

(1) During the evaluation, the helicopter was maintained by the manufacturer's representative with military personnel provided for servicing, general assistance, and maintenance of records. Maintenance requirements will not differ from those of Army helicopters presently used for the primary helicopter training mission.

(2) Engine operation was trouble free on standard Army aviation fuel (115/145) and lubricants.

(3) The helicopter was easy to service and maintain.

(4) During the test, an engine and main rotor head change was required.

(5) Tools and ground support equipment normally found at the organizational level were adequate for organizational maintenance. Special tools are required for higher echelons of maintenance.

2. Evaluation of Manufacturer's Technical Proposal. The manufacturer's technical proposal to configure the test helicopter to meet the Model Specification was reviewed and the following was determined.

a. Proposed electronic configuration was satisfactory.

b. Required floor-mounted and cyclic-control-mounted radio-interphone keying switches were proposed for both student and instructor pilot stations.

c. Required shoulder harnesses with inertia reels were not specified.

d. Proposed alternate left-right seating is considered superior to seating arrangement installed on test helicopter (left, instructor; center, student), because of improved visibility for student and elimination of the possibility of the instructor interfering with the student pilot's collective pitch movements.

e. An attitude indicator was proposed.

f. The USABAAR evaluation (paragraph C, section two) is summarized as follows: "The evaluation considered the categories of Operational Safety, Maintenance Safety, and Crashworthiness. In each of these categories, USABAAR found the aircraft to be acceptable for its intended mission. Certain discrepancies, which would detract from its mission capability, were noted."

g. The USAAHUMRU evaluation (paragraph D, section two) is summarized as follows: "The human factors design of the crew area of the PH-7 was found to be adequate for mission accomplishment with the exception of the heating system."

3. Comparison with Model Specification and Statement of Requirement. In determining whether the PH-7 met the requirements of the Model Specification and Statement of Requirement, the characteristics of the helicopter as tested and an evaluation of the manufacturer's technical proposal were considered.

a. Comparison with Model Specification.

| Mod. Spec. Para. No. | Model Specification as Amended | PH-7 Meets Spec. | Remarks |
|---|---|---|---|
| 1. | SCOPE. | | |
| 1.1 | Scope. This detailed specification covers the essential requirements for the design of a single engine primary helicopter trainer capable of performing the mission specified in 1.2. | | |
| 1.1.1 | Designation and General Description. | | |
| | Army Model Designation - Primary Helicopter Trainer (Army Model Number not yet assigned) | | |
| | Number of crew - 1 pilot | Yes | |
| | Number of passengers - 1 student | Yes | |
| | Crew and passenger seating arrangement - side by side | Yes | |
| | Flight Controls - Dual | Yes | |
| | Type of Engine - Reciprocating | Yes | |
| | Main Rotor System - Single | Yes | |
| 1.2 | Mission. The primary Army mission for which the helicopter will be employed is training of mili- | Yes | |

| Mod. Spec. Para. No. | Model Specification as Amended | PH-7 Meets Spec. | Remarks |
|---|---|---|---|
| | tary pilots in the basic operation and performance of a helicopter. Training will be accomplished under conditions to which Visual Flight Rules apply. | | |
| 1.3 | Federal Aviation Agency Certification. The helicopter will have a Part 6 standard airworthiness certificate issued by the Federal Aviation Agency. | No | Test helicopter was not FAA certificated and did not have a type inspection report issued by FAA. |
| 1.4 | Performance Information. Those items of performance stated as requirements herein which are not included in the FAA approved flight manual are subject to verification by the US Army. | Yes | |
| 2. | APPLICABLE DOCUMENTS. | | |
| 2.1 | The documents applicable to this specification are those necessary to fulfill the requirements of paragraph 1.3, Federal Aviation Agency Certification. | No | Tested helicopter did not have TIR. |
| 3. | REQUIREMENTS. | | |
| 3.1 | Basic Weight. The basic weight of the helicopter will include all required installed equipment including the items of paragraph 3.7, 3.8.1.1, 3.8.1.2 and | Yes | |

| Mod. Spec. Para. No. | Model Specification as Amended | PH-7 Meets Spec. | Remarks |
|---|---|---|---|
| | the Electronic Equipment as stated in Table E, Appendix I. | | |
| 3.2 | Center of Gravity Travel. Addition, removal or relocation of ballast or aircraft components will not be necessary in order to maintain the CG within CG limits due to changes in loading of the helicopter with respect to fuel, pilot and student. | Yes | |
| 3.3 | Useful Load. The useful load of the helicopter will be sufficient for 400 lbs. ~~in addition to the fuel and~~ *oil necessary to accomplish* the 2 1/2 hour endurance mission specified in paragraph 3.4.1. | Yes | |
| 3.4 | Required Performance. | | |
| 3.4.1 | ICAO Sea Level Standard Day Performance (at certificated gross weight). | | |
| | Cruise Speed (Minimum) - 65 knots | Yes | |
| | Endurance (Minimum) - 2 1/2 hours at 65 knots cruise speed. | Yes | |
| | Rate of Climb (Minimum) - 1000 ft. per minute | Yes | |

| Mod. Spec. Para. No. | Model Specification as Amended | PH-7 Meets Spec. | Remarks |
|---|---|---|---|
| 3.4.2 | Hovering Performance Requirement. At certificated gross weight the aircraft shall hover out of ground effect at 1000 ft. at 110° F. | Yes | |
| 3.4.3 | Autorotation Characteristics (at certificated gross weight). | | |
| 3.4.3.1 | Normal Autorotation Speed. The manufacturer will designate a speed for normal autorotation not to exceed 45 knots. | Yes | |
| 3.4.3.2 | Rate of Descent. At the speed designated in 3.4.3.1 the helicopter will not exceed a stabilized autorotation rate of descent of 2200 feet per minute under conditions of 1000 ft. altitude and 110° F. | Yes | |
| 3.4.3.3 | Rotor RPM Decay. In autorotation at the speed in 3.4.3.1 and conditions of 1000 ft. and 110°F., if rotor RPM decays to the lower rotor RPM limit, the helicopter will be capable of regaining normal operating RPM (as specified by the manufacturer) and with an altitude loss not to exceed 200 feet. | Yes | |

| Mod. Spec. Para. No. | Model Specification as Amended | PH-7 Meets Spec. | Remarks |
|---|---|---|---|
| 3.5 | Aircraft Structure | | |
| 3.5.1 | Landing Gear. | | |
| 3.5.1.1 | Type Landing Gear. Skid type landing gear which will permit running take-offs and landings. | Yes | |
| 3.5.1.2 | Slope Landings. The landing gear will permit cross slope landings on slopes of $15^{o}$. | Yes | |
| 3.5.1.3 | Ground Handling. Ground handling wheels are required. Weight of the ground handling wheels will not be included in the weight empty if they are detachable. | Yes | |
| 3.5.1.4 | Hoisting, Jacking and Mooring. Provisions will be made for hoisting, jacking and mooring. | Yes | |
| 3.5.2 | Main Rotor Blades. | | |
| 3.5.2.1 | Blade Interchangeability. The main rotor blades will be individually interchangeable. | Yes | |
| 3.5.3 | Control Pedals. Both sets of directional control pedals of the aircraft will be adjustable. | Yes | |

| Mod. Spec. Para. No. | Model Specification as Amended | PH-7 Meets Spec. | Remarks |
|---|---|---|---|
| 3.5.4 | Operating Environment. | | |
| 3.5.4.1 | Aircraft Operation. The aircraft will be capable of operating in temperatures from 0°F. to +100°F. | Undetermined | Temperatures during tests ranged from 75°F. to 95°F. |
| 3.5.4.2 | Cabin Heating. The aircraft will have a heating system which provides a minimum of 50°F. cabin temperature with 0°F. outside air temperature. This condition need only be satisfied with the engine operating. | Undetermined | Heater was placarded prohibiting operation during hover. Due to temperature ranges this test could not be conducted. |
| 3.6 | Fuel and Lubricants. The engine will operate on such fuel and lubricants which are now established as standard by the US Army. (Ref. MIL G-5572C dated 12 Jul 60 and MIL-L-22851 dated 30 June 61 and MIL-L-6082C, dated 18 May 61.) | Yes | |
| 3.7 | Instruments and Navigational Equipment. Flight instruments and lights for day and night VFR conditions shall be furnished and installed by the contractor. | Yes | |
| | An attitude indicator shall be provided as part of the basic aircraft instrumentation. | Yes | |

| Mod. Spec. Para. No. | Model Specification as Amended | PH-7 Meets Spec. | Remarks |
|---|---|---|---|
| 3.8 | Electrical. | | |
| 3.8.1 | Lighting. | | |
| 3.8.1.1 | Anti-Collision Light. The aircraft will have an anti-collision light. The light will be located to prevent reflection into the cockpit. | Yes | |
| 3.8.1.2 | Landing Light(s). The aircraft will be equipped with landing light(s) which will be adjustable. The landing light switch will be located on the pilot's cyclic or collective control. | Yes | |
| 3.8.2 | Power Receptacle. The aircraft will be equipped with an external power receptacle of an AN or AMS standard design. | Yes | |
| 3.8.3 | Switches and Auxiliary Controls. All switches and auxiliary controls necessary for flight and navigation will be accessible and within reach of the student pilot and the instructor pilot. Switches and controls shall be operable in flight by personnel wearing winter flight clothing. | Yes | |
| | Accessible floor mounted and cyclic control mounted radio-interphone switches | Yes | |

| Mod. Spec. Para. No. | Model Specification as Amended | PH-7 Meets Spec. | Remarks |
|---|---|---|---|
| | will be provided for both student pilot and instructor. | | |
| 3.9 | Electronic Equipment. The aircraft will be equipped with the electronic equipment as indicated in appendix I. | Yes | |
| 3.10 | Safety Equipment. Seat belt and shoulder harness will be furnished for all occupants. | Yes | Seat belts did not meet military specification. |
| | APPENDIX I | | |
| | Communication | | |
| | UHF - AN/ARC-45, 1 ea. | Yes | GFE |
| | ICS - C-1611, 2 ea. | Yes | GFE |
| | Miscellaneous | | |
| | Antenna - AT-450/ARC, 1 ea. | Yes | GFE |
| | Battery - Sonotone MA-7, 1 ea. | Yes | |
| | Inverter (If required either inverter listed will be a suitable substitute for standard equipment.) - Leland MIL-E-93-200 or Bendix 328-172-1, 1 ea. | Yes | Technical proposal specifies MIL-E-93-200. |

b. Comparison with Statement of Requirement. A comparison with the Statement of Requirement (reference 4), excluding those requirements covered by the Model Specification, follows:

| Requirement | PH-7 Meets Requirement | Remarks |
|---|---|---|
| Size. | | |
| It is desired that the external dimensions of the helicopter, less rotor, not exceed 8 feet in height, 23 feet in length, and 7 feet in width. | No | Helicopter height 10.2 feet, length 27.8 feet, and width 7.5 feet. |
| With full cyclic movement, the rotor blade tip clearance above the ground level should not be less than 6 feet with rotors turning. | No | With cyclic centered and at normal rotor r.p.m., ground-to-main-rotor clearance was satisfactory. |
| A minimum rotor diameter consistent with good autorotative characteristics is desired. | Yes | |
| Structure and Design. | | |
| The following will be required: | | |
| Main rotor blades which are interchangeable, without retracking desirable. | Yes | |
| If more than two main rotor blades, provisions should be provided for simple expeditious folding and unfolding. | N/A | |
| It shall be free from ground resonance. | Yes | |

| Requirement | PH-7 Meets Requirement | Remarks |
|---|---|---|
| Suitable seat belt and shoulder harness for both student pilot and instructor. | No | Seat belts did not meet military specification and inertia reels were not specified in the technical proposal. |
| Electrical. | | |
| The following are required: | | |
| Lighting; adequate position, cockpit, anti-collision and landing lights for night flight. Position and anti-collision lights to be positioned to prevent reflection into cockpit; landing light to be adjustable. | Yes | |
| Durability and Reliability. | | |
| Engine and dynamic components should not be materially affected by dust, sand, moisture, etc., encountered in operation from unprepared areas. | Undetermined | |
| Noise Level. | | |
| The lowest possible noise level is desired without use of a complex or elaborate muffler system or extension or heavy insulation. | Yes | Exceeded MIL-A-8806 in all areas (reference paragraph A, section two). |
| Personnel Considerations. | | |
| No new personnel skills will be required. | Yes | Due to similarity of the helicopter to other helicopters in the Army |

| Requirement | PH-7 Meets Requirement | Remarks |
|---|---|---|
| | | inventory, no new skills will be required. |
| Training Considerations. | | |
| No new training requirements will be generated. | Yes | No new training requirements for technical service schools are required. |
| No supporting training devices other than those on hand at the US Army training base are required. | Yes | |

D. Deficiencies and Shortcomings.

1. *The following deficiencies were noted during conduct of the test:*

| Deficiencies | Suggested Corrective Action |
|---|---|
| a. Installed seat belts did not meet military specification. | Install seat belts which meet military specification. |
| b. Heater was unsatisfactory because it could not be used during hovering flight. | Provide satisfactory heater installation. |
| c. Stability with hydraulic boost off was unsatisfactory. | Provide satisfactory stability with hydraulic boost off. |
| d. Controllability with hydraulic boost off was unsatisfactory. | Provide satisfactory controllability with hydraulic boost off. |
| e. Inertia reels for shoulder harnesses were not specified. | Install inertia reels for shoulder harnesses. |

2. The following shortcomings were noted during conduct of the test:

| Shortcoming | Suggested Corrective Action |
|---|---|
| a. Center-left seating arrangement was considered unsatisfactory because of the close proximity of the student's collective control to the instructor's position. | Provide left-right seating arrangement. |
| b. Engine power can be inadvertently decreased when increasing throttle friction. | Provide throttle friction that tightens in the same direction as application of power. |
| c. Manifold bleed-air control was located behind the left instrument console ash tray and was inaccessible. | Relocate manifold bleed-air control. |
| d. Magnetic chip detectors were not installed. | Install magnetic chip detectors of the continuous read-out type type in the transmission and engine oil sumps. |
| e. Heater could not be operated at a hover. | Relocate heater intake valve. |

## SECTION TWO

## Reports from Other Agencies on the PH-7

PARAGRAPH A

Aviation Field Operations Division
U. S. ARMY AEROMEDICAL RESEARCH UNIT
Fort Rucker, Alabama 36362

USAARU-FO 29 July 1963

REPORT ON PH-7

1. Method of Testing.

a. The heating and ventilation evaluation of the PH-7 consisted of comparisons of outside air temperature and cockpit air temperature with the aircraft under all operating conditions. In conjunction with these checks, a carbon monoxide test was also made.

b. Equipment consisted of:

(1) Weston Aneroid Thermometer, Model 2291.

(2) Mine Safety Appliance Company Carbon Monoxide Tester, Category No. DS-47133.

2. Results. (See Annex A)

3. Discussion.

a. Although reasonably high temperatures were encountered on the aircraft with doors on, windows closed and vents closed (see Annex A), it is felt that this aircraft will rarely be operated under those conditions with existing outside temperatures in the 90°F. range.

b. The recommended maximum temperatures for clothed men not especially acclimatized are as follows:

(1) Resting in still air - 88°F.

(2) Resting, with some air movement (170 FPM air velocity) - 93°F.

(3) Moderate work, still air - 78°F.

Reference: Patty, Frank A., Industrial Hygiene & Toxicology (2d ed., Vol. 1; New York: Interscience Publishers Inc., 1958).

c. Comparing recommended working temperatures (see above) with temperatures found in aircraft (see Annex A), a mean working temperature of 95°F. was derived. This is felt to be within limits with existing outside air temperature running in the 90°F. range.

d. Carbon monoxide was not found in this aircraft at any time.

e. The heater was checked with aircraft on the ground, engine at operating RPM, door, vents, and windows closed. With outside air being in the 90°F. range, cockpit temperature rose to above 120°F. within 3 minutes. Heater is felt to be excellent.

/s/ J. C. Rothwell
/t/ J. C. ROTHWELL
Captain, MSC
Ass't Chief, Avn Fld Opns Div

1 Incl
as

## HEATING AND VENTILATION EVALUATION OF OFF-THE-SHELF HELICOPTER TRAINERS

PH-7

Analyzed by: Captain Rothwell  Date: 14 June 1963

| | %CO | | TEMP | |
|---|---|---|---|---|
| | A/C | Out | A/C | Out |
| VENTILATION | | | | |
| On Ground | | | | |
| Doors Off (P) | 0 | - | 96 | 95 |
| Doors On - Window Open | 0 | - | 98 | 95 |
| Doors On - Window Closed, Vent Open | 0 | - | 100 | 95 |
| Doors On - Window Closed, Vent Closed | 0 | - | 104 | 95 |
| Hover | | | | |
| Doors Off (P) | 0 | - | 95 | 94 |
| Doors On - Window Open | 0 | - | 98 | 94 |
| Doors On - Window Closed, Vent Open | 0 | - | 103 | 94 |
| Doors On - Window Closed, Vent Closed | 0 | - | 105 | 94 |
| In-Flight | | | | |
| Doors Off (P) | 0 | - | 93 | 92 |
| Doors On - Window Open | 0 | - | 92 | 92 |
| Doors On - Window Closed, Vent Open | 0 | - | 100 | 92 |
| Doors On - Window Closed, Vent Closed | 0 | - | 102 | 92 |
| HEATING | | | | |
| On Ground, Engine at operating RPM, doors, vents and windows closed | | | | |
| Heater "Off" | 0 | - | 98 | 97 |
| Heater "On" | 0 | - | 126 | 104 |

ANNEX A

Aviation Field Operations Division
U. S. ARMY AEROMEDICAL RESEARCH UNIT
Fort Rucker, Alabama 36362

USAARU-FO

29 July 1963

# NOISE EVALUATION OF THE PH-7

1. Methods and Equipment.

a. Due to the number of aircraft to be tested and the short time available, the noise analysis was limited to the following:

(1) "A" - 24-55 db: sound level for speech interference.

(2) "B" - 55-85 db: sound level for noise survey.

(3) "C" - 85-140 db: sound pressure level--over-all frequency response.

b. A General Radio, Sound-Level-Meter, type 1551-C, was used for the noise measurements.

c. The test area, located at County Line Strip, is a pre-marked compass rose with a 50 foot radius.

2. Results. (See Annex A)

3. Discussion.

| | Doors On | Doors Off | MIL-A-8806 |
|---|---|---|---|
| Normal cruise | 109 | 114 | 106 |
| Maximum cruise | 110 | 114 | 113 |

a. Operation of this helicopter at normal and maximum cruise with the doors on or off produced excessive sound pressure levels of 109, 110, and 114 which exceed Tables I and IV MIL-A-8806.

b. There are no military specifications for external noise. Raw data is included for purpose of comparison only.

4. Summary. Improvements should be made to reduce noise levels to meet military specifications (MIL-A-8806).

/s/ William C. Thrasher
/t/ WILLIAM C. THRASHER
2/Lt., MSC
Ass't Chief, Avn Fld Opns Div

1 Incl
as

NOISE LEVEL MEASUREMENTS-OCTAVE BAND ANALYSIS

DATA COLLECTION SHEET

Analyzed by Lt W. C. Thrasher
S/Sgt Lonnie Parsons

Date 14 June 1963

PH-7

| DOORS-ON | A | B | C | Center | Student | Indic Air Speed | Mani-fold | RPM | Radius |
|---|---|---|---|---|---|---|---|---|---|
| Ground idle | 92 | 100 | 105 | | 1 | - | 9.5" | 2100 | |
| Ground high power | 99 | 105 | 109 | | 1 | - | 16 | 3200 | |
| Hover | 100 | 106 | 109 | | 1 | - | 19.3 | 3200 | |
| Normal cruise | 100 | 105 | 109 | | 1 | 80 | 22 | 3100 | |
| Maximum cruise | 102 | 106 | 110 | | 1 | 100 | 24 | 3200 | |
| DOORS-OFF | | | | | | | | | |
| Ground idle | 103 | 102 | 106 | | 1 | - | 9.5 | 2100 | |
| Ground high power | 100 | 107 | 110 | | 1 | - | 16 | 3200 | |
| Hover | 102 | 108 | 111 | | 1 | - | 19.3 | 3200 | |
| Normal cruise | 101 | 107 | 114 | | 1 | 80 | 22 | 3100 | |
| Maximum cruise | 103 | 109 | 114 | | 1 | 100 | 24 | 3200 | |
| EXT HIGH POWER | | | | | | | 16.0 | 3200 | |
| 0 | 91 | 101 | 104 | | | | | | 50' |
| 30 | 93 | 101 | 103 | | | | | | |
| 60 | 94 | 101 | 104 | | | | | | |
| 90 | 98 | 105 | 108 | | | | | | |
| 120 | 101 | 108 | 110 | | | | | | |
| 150 | 103 | 110 | 112 | | | | | | |
| 180 | 101 | 109 | 112 | | | | | | |
| HOVER | | | | | | | | | |
| 0 | 91 | 99 | 105 | | | | 19.3 | 3200 | 50' |
| 30 | 94 | 100 | 104 | | | | | | |
| 60 | 95 | 102 | 106 | | | | | | |
| 90 | 101 | 107 | 109 | | | | | | |
| 120 | 103 | 109 | 111 | | | | | | |
| 150 | 105 | 112 | 115 | | | | | | |
| 180 | 101 | 110 | 113 | | | | | | |

ANNEX A

Aviation Field Operations Division
U. S. ARMY AEROMEDICAL RESEARCH UNIT
Fort Rucker, Alabama 36362

USAARU-FO 29 July 1963

# LIGHT EVALUATION OF THE PH-7

1. Methods and Equipment.

a. The evaluation consisted of in-flight analysis of the aircraft's lighting system under night conditions. Criteria for this evaluation were derived from U. S. Navy Specifications governing cockpit and instrument panel illumination modified to meet Army requirements.

b. A standard Norwood photo-electric meter was used to measure overall cockpit illumination from the auxiliary hand light or map light.

2. Results. (See Annex A)

3. Discussion.

a. All instruments were adequately illuminated with standard red light with the exception of the lower instrument panel and control console which were completely dark.

b. Reflections from the instrument panel lights were noted on the right and left sides of the bubble. These reflections should be eliminated to assure adequate peripheral vision.

c. Warning and caution lights should be dimmed for night operations in order to safeguard the pilot's night vision.

d. The map light should be mounted in a position convenient for the student to read approach plates and charts while flying the aircraft.

USAARU-FO 29 July 1963
SUBJECT: Light Evaluation of the PH-7

4. Summary. By improving the deficiencies mentioned above, the cockpit illumination of this aircraft could satisfy military illumination standards for a primary and instrument trainer.

/s/ William C. Thrasher
/t/ WILLIAM C. THRASHER
2/Lt., MSC
Ass't Chief, Avn Fld Opns Div

1 Incl

Aviation Field Operations Division
U. S. ARMY AEROMEDICAL RESEARCH UNIT
Fort Rucker, Alabama

COCKPIT LIGHT STUDY
PH-7

1. Are all instruments adequately illuminated? No (Note para 3a)

2. Are they illuminated uniformly? No Is there sufficient intensity? Yes

3. Is illumination controllable to very low intensities? Yes (Rheostat)

4. Are markings of instruments readable? Yes

5. Are all controls, instructions, and nameplates adequately illuminated? No (note para 3a).

6. Are they illuminated uniformly? No Is there sufficient intensity? No

7. Is illumination controllable to very low intensities? Yes

8. Are markings on controls, instructions and nameplates readable? -----

9. Is the intensity of lighting for some instruments and controls controlled separately? Yes, an auxiliary light.

10. Is flood lighting provided? Yes Is the light standard red? Yes

11. Is the power source independent of normal lighting circuit? Yes

12. Are there any sources of light which give other than standard red light? No

13. Are there any reflections in the windshield, windows, canopy or other reflecting surfaces which interfere with visibility inside or outside the cockpit? Yes (note para 3b).

14. Is there light leakage into the cockpit from other compartments? No

Annex A

15. Are spare lamps provided in sufficient quantity and easily accessible? N/A

16. Are all instruments, instructions, nameplates, and control markings readable in daylight? Yes

17. Can warning and caution lights be dimmed sufficiently for night operations? No (note para 3c)

18. Are warning and caution lights of sufficient intensity for daylight use? Yes

19. Are warning and caution lights on the main dimming circuit? No

20. Is lighting provided in accordance with the aircraft detail specification? -----

21. Is the light adequate for reading? Yes

22. Does the light cause glare to cockpit? No

23. Is there adequate general illumination for the compartment? No (note para 3d)

24. Do any of the exterior lights provide glare in the cockpit? No

25. Is exterior lighting provided in accordance with FAA? Yes

Map light rated at 32 footcandles with light 14 inches from photometer.

PARAGRAPH B

HEADQUARTERS
UNITED STATES ARMY PRIMARY HELICOPTER SCHOOL
Fort Wolters, Mineral Wells, Texas

AKPWO-HS 30 September 1963

SUBJECT: Evaluation of Mission Suitability of the Primary Helicopter Trainer (Off the Shelf) USATECOM Project No. 4-3-1000-01-A

TO: President
US Army Aviation Test Board
Fort Rucker, Alabama

Attached hereto are reports of evaluation of mission suitability for the PH-6, PH-7, and PH-9 Helicopters.

/s/ J. E. Gonseth, Jr
/t/ J. E. GONSETH, JR
Colonel, Signal Corps
Commandant

3 Incls
1. PH-6
2. PH-7
3. PH-9

## PARAGRAPH B

## EVALUATION OF MISSION SUITABILITY OF THE PH-7 HELICOPTER AS CONDUCTED BY THE UNITED STATES ARMY PRIMARY HELICOPTER SCHOOL

1. Scope. Experienced primary flight instructors from the US Army Primary Helicopter School conducted primary flight training with qualified student officers with no previous flight experience and transition training for rated Army aviators with varied experience in observation helicopters. The helicopter was repeatedly flown through typical training missions with the students being required to perform maneuvers included in the approved flight syllabus of the US Army Primary Helicopter School, Fort Wolters, Texas.

2. Findings.

a. Hovering. The helicopter performed this maneuver in an acceptable manner.

b. Normal Take-Off and Normal Approach. The helicopter performed this maneuver in an acceptable manner, except the center seating position of the student pilot places him behind the console which blocks forward visibility at approach termination.

c. Maximum Performance Take-Off and Steep Approach. The helicopter performed this maneuver in an acceptable manner, except the center seating position of the student pilot places him behind the console which blocks forward visibility at approach termination.

d. Running Take-Off and Landing. The helicopter performed this maneuver in an acceptable manner.

e. Hovering Autorotations. The helicopter performed this maneuver in an acceptable manner.

f. Autorotations. The helicopter performed this maneuver in an acceptable manner; however, the rate of descent in autorotation is higher than desired for a Primary Trainer. Forward visibility from the center seat is poor.

g. Simulated Forced Landings. The helicopter performed this maneuver in an acceptable manner; however, the rate of descent in autorotation is higher than desired for a Primary Trainer. Forward visibility from the center seat is poor.

h. Decelerations. The helicopter performed this maneuver in an acceptable manner.

i. Simulated Anti-Torque Control Failure. The helicopter performed this maneuver in an acceptable manner.

3. Comparison with Criteria for Evaluation of Mission Suitability of "Off the Shelf" Primary Helicopter Trainers. A comparison of the characteristics of the helicopter with the Criteria for Evaluation follows:

| Criteria for Evaluation | Helicopter Meets Criteria | Remarks |
|---|---|---|
| Flight Controls (Cyclic, collective and anti-torque): Must have a rapid and positive response with no tendency to over-shoot in response to corrections in powered and non-powered flight due to the general inability of the student pilot to treat any aircraft with the same finesse and care of a seasoned pilot. | Yes | |
| Stability: Inherent stability in the vertical, longitudinal and lateral axis that will absorb power changes (power to non-power and non-power to power, intentional/inadvertent) with minimum corrective action required to regain positive control. | Yes | |
| Power Reserve: Provide an adequate power reserve that will allow the instructor pilot to contain or recover from unusual situations induced by student errors. | Yes | |

| Criteria for Evaluation | Helicopter Meets Criteria | Remarks |
|---|---|---|
| Autorotative Characteristics: Rotor mass and inertia adequate to allow for student error in autorotative landings. | Yes | The PH-7 meets the autorotative characteristics criteria with the exception of a higher rate of descent than desired in a primary trainer. See para 2 f and g. |
| Latitude for Student Error: Inherent flight characteristics that will allow a student to make an identifiable error and still have sufficient latitude for the student pilot and/or instructor pilot to make a recovery. No preflight or starting techniques that would demand detailed procedure or unusual knowledge on the part of the student pilot and instructor pilot. | Yes | |
| Training Endurance Considerations: Adequate ventilation, heating and defrosting equipment. Ample shoulder room between instructor pilot and student and between collective pitch control and the door. Comfortable seat cushions to allow four hours of flight without undue fatigue. | Yes | The PH-7 meets the training endurance considerations with the exception of shoulder room between the IP and student. |
| Location of Controls: Trim controls if required on each cyclic stick. Any control locking or safety devices in sight and reach of the instructor pilot. | Yes | |
| Ground Resonance: Must be free from ground resonance. | Yes | |

4. Conclusion: The PH-7 is suitable for use as a Primary Helicopter Trainer.

PARAGRAPH C

BAAR-P 6 September 1963

SUBJECT: USABAAR's Evaluation of PH-7 Off-The-Shelf Primary Helicopter Trainer

TO: President
U. S. Army Aviation Test Board
ATTN: Off-the-Shelf Project Officer
Fort Rucker, Alabama

1. The following is USABAAR's evaluation of the PH-7 entry for the off-the-shelf primary helicopter trainer competition. The evaluation considered the categories of aviation safety and accident prevention in three primary categories. In each of these categories, USABAAR found the aircraft to be acceptable for its intended mission. However, there are certain deficiencies which will detract from its mission capability and should be considered by those responsible for selecting the winner of the competition. Categories considered are:

a. Operational Safety: This category considers those features of the aircraft and its operating characteristics that are considered to be conducive to accident causation and which may detract from the operator's ability to maintain safe flight at all times.

b. Maintenance Safety: This category considers maintenance design features of the aircraft contributing to accident causation. It includes those features of "Murphy's Law," ease of inspection, accessibility for component replacement, the preflight inspections imposed on the operator, etc.

c. Crashworthiness: This category considers design features of the aircraft that, in the event of a crash, provide protection to the occupants from injury. It also includes features of crash-fire worthiness.

2. Evaluation comments are as follows:

BAAR-P 6 September 1963

SUBJECT: USABAAR's Evaluation of PH-7 Off-the-Shelf Primary Helicopter Trainer

a. Operational Safety:

(1) Navigation lighting creates slight detracting reflections on the bubble during night operations.

(2) The short skid shoe installation exposes skids to catching on ground objects. Installation of full length skid shoes is required to preclude snagging ground objects.

b. Maintenance Safety:

Magnetic chip detector - Install magnetic chip detectors and cockpit warning lights of the continuous readout type in the transmission and engine oil sumps.

c. Crashworthiness:

(1) Cockpit lacks structural members which would protect crew members in the event of roll-over or landing hard at other than a level attitude.

3. If any of the above noted discrepancies are eliminated due to manufacturer's proposal, they are of no consequence.

4. The following features are recognized as desirable and considered worthy of mention:

a. The number of post-crash fires of the basic PH-7 airframe construction has been negligible as evidenced by accident record on file in USABAAR.

b. Controllability and stability during flight is excellent.

/s/ Robert Hamilton
/t/ ROBERT HAMILTON
Colonel, Infantry
Director, USABAAR

## PARAGRAPH D

### U. S. ARMY AVIATION HUMAN RESEARCH UNIT
Fort Rucker, Alabama

Human Factors Evaluation of PH-7 Primary Trainer

1. Summary

1.1 The human factors design of the crew area of the PH-7 primary training helicopter was found to be adequate for mission accomplishment with the exception of the heating system.

2. Detailed Considerations

2.1 The heating system is unsatisfactory due to the fact that it cannot be used during ground operations or while hovering. As a sizeable proportion of primary training consists of ground operation and hovering, the crew's winter comfort is sharply impeded by this deficiency.

2.2 The location of the attitude indicator and electrical system master switch adjacent to the lighting switches is undesirable. A guarded or lift-type safety switch should be used for these switches, and preferably, they should be separated to avoid the possibility of cutting off electrical power while intending to turn off the attitude indicator. This event would also turn off the lights required for finding the master switch itself and at night could produce total lack of instrument information.

2.3 A cover over the attitude indicator is considered preferable to switching off the power to this instrument. When this instrument does not present correct attitude it is very distracting to both students and instructors who have established a scanning pattern including it. A complete blank is preferable to incorrect information.

/s/ Robert H. Wright
/t/ ROBERT H. WRIGHT, Ph. D.
Research Scientist

and

/s/ H. Alton Boyd, Jr.
/t/ H. ALTON BOYD, JR.
Research Associate

## UNIT F - COMPANY A MODEL PH-9

### SECTION ONE

### USAAVNTBD REPORT

A. Description of Materiel.

1. The PH-9 is a single-engine, two-place, side-by-side, three-bladed single main rotor, and tail rotor type helicopter. Power is supplied by an HIO-360-B1A horizontally-mounted, four-cylinder, opposed type air-cooled, non-supercharged, fuel injection engine which provides maximum rated power at sea level of 180 b.hp. at 2900 r.p.m. Engine power is transmitted to the rotors through drive shafts, a belt drive, and reduction gears. The lower pulley of the belt drive is connected to the engine. The upper pulley is mounted on the main gear box pinion, the end of which is also splined to the tail-rotor drive shaft. The belt-drive assembly incorporates an idler pulley, controlled from the cockpit, which acts as a clutch for engaging and disengaging the engine from the rotor.

2. Flight controls consist of a cyclic stick, collective pitch stick, and antitorque pedals. Electrically operated bungees are provided for longitudinal and lateral cyclic trim control. Adjustable friction devices are provided for the collective pitch and cyclic controls.

3. The main rotor is fully articulated and utilizes three all-metal rotor blades. A two-bladed antitorque tail rotor mounted on a delta hinge provides directional control.

4. The fuselage components are attached to the central framework of steel tubing. The seat, floor, and main rotor mast support structure form a detachable unit and are fabricated from sheet metal. A tail boom is fabricated from a single piece of aluminum tubing. A transparent plastic canopy, tinted overhead, is provided. A skid-type landing gear incorporates oleo-type struts between cross tubes and skids. Ground-handling wheels are removable and are normally positioned at the front of the skids for flight.

5. General dimensions of the helicopter submitted for test are listed below:

| | | |
|---|---|---|
| a. | Overall height | 8 feet 2.6 inches |
| b. | Overall length(main rotor tip to tail rotor tip) | 28 feet 4.8 inches |
| c. | Rotor diameter | 25 feet 3.5 inches |
| d. | Fuselage width | 4 feet 3.0 inches |
| e. | Skid gear tread (maximum) | 6 feet 6.5 inches |

B. Scope of Test. The test was conducted by USAAVNTBD project officers and USAPHS instructor personnel. The test consisted of three phases: a 60-flying-hour test; a study of the manufacturer's technical proposals which described changes to configure the test helicopter to meet the stated requirements; and a comparison of the helicopter with the Model Specification and the Statement of Requirement. In addition, the US Army Board for Aviation Accident Research (USABAAR) evaluated the aviation safety aspect; the US Army Aviation Human Research Unit (USAAHUMRU) evaluated the human factors aspect; and the US Army Aeromedical Research Unit (USAARU) evaluated noise level, internal lighting, and heating and ventilation.

C. Tests.

1. Evaluation of Physical and Flight Characteristics, Performance, Mission Suitability, and Maintenance.

a. Physical Characteristics.

(1) Basic and Operating Weights. The helicopter was weighed as delivered with oil and trapped (unusable) fuel. To this weight (963 pounds), the weight of electronic and auxiliary equipment required for Army use (95 pounds) was added, and the weight of currently-installed equipment not required for Army use (28 pounds) was subtracted, resulting in a total estimated basic weight of 1030 pounds. The estimated mission operating weight was then computed by adding to the estimated basic weight the weight of fuel (150 pounds) and 400 pounds (instructor and student). Details follow:

| | |
|---|---|
| EMPTY WEIGHT as weighed (less ground-handling wheels) | 963 lb. |

| | | |
|---|---|---|
| Weight of required equipment to be added: | | |
| Shoulder harness and inertia reel (2 ea.) | 6 lb. | |
| First-aid kit and fire extinguisher | 10 lb. | |
| AN/ARC-45 (UHF) | 27 lb. | |
| C-1611 interphone (2 ea.) | 4 lb. | |
| Attitude indicator (proposed) | 3 lb. | |
| MA-7 battery | 34 lb. | |
| Heater (proposed) | 11 lb. | |
| TOTAL ADDED | 95 lb. | 95 lb. |
| | | 1058 lb. |
| Weight of installed equipment to be removed: | | |
| Commercial radio | 7 lb. | |
| Twelve-volt battery | 21 lb. | |
| TOTAL SUBTRACTED | 28 lb. | -28 lb. |
| TOTAL BASIC WEIGHT (estimated) | | 1030 lb. |
| Fuel | | 150 lb. |
| Instructor and Student | | 400 lb. |
| MISSION OPERATING WEIGHT (estimated) | | 1580 lb. |
| REMAINING AVAILABLE PAYLOAD | | 90 lb. |
| MAXIMUM CERTIFICATED GROSS WEIGHT | | 1670 lb. |

(2) Center-of-Gravity Travel. Control travel was sufficient to provide control at the extremes of allowable center-of-gravity (CG) position at maximum certificated and normal operating

gross weights. The addition, removal, or relocation of ballast or aircraft components was not necessary for the helicopter to remain within CG limits when changes were made in loading of the helicopter with respect to fuel, instructor, and student. No determination was made of the helicopter's CG travel when flown from the left seat as the rotor engage lever could not be operated from the left seat.

(3) Ground Clearance. Ground clearance was sufficient for operation in unimproved areas; however, engine exhaust stacks did present a fire hazard in tall grass. At normal operating r.p.m. ground-to-main-rotor clearance was satisfactory with cyclic stick centered but did not meet specifications when cyclic was fully displaced.

(4) Ground-Handling Characteristics. Ground-handling characteristics of the helicopter, with removable wheels provided, were satisfactory.

(5) Suitability for Hoisting, Jacking, and Mooring. The helicopter was equipped with suitable hoisting and jacking hard points and had suitable locations on the structure for attachment of mooring lines.

(6) Suitability of External Power Receptacle. The test helicopter was not equipped with an external power receptacle. The manufacturer's technical proposal included an external power receptacle which was compatible with Army APU's.

(7) Adequacy of Cockpit Configuration and Arrangement. The cockpit configuration and arrangement of the test helicopter were evaluated, except for those items changed in the manufacturer's technical proposal. The cockpit configuration and arrangement were satisfactory except for the following:

(a) The rotor-engage lever was accessible from the student pilot station (right seat) only and could not be operated from the instructor pilot station (left seat).

(b) The engine could be started with the rotor-engage lever in the engage position. This results in dephasing of dampers and possible damage to the main rotor system.

(c) No provisions were made for quick-disconnect of the battery.

(d) A stop was not provided on the mixture control to prevent accidental fuel starvation of the engine.

(e) An ammeter measuring the charge-discharge rate of the battery was provided in lieu of a load meter (volt-ammeter) measuring the load on the generator.

(f) The location of cyclic friction controls (longitudinal and lateral) was unsatisfactory. Friction controls were accessible from the student position only and required release of the collective pitch control to operate.

(g) Installed seat belts do not meet Military Specification.

(h) Engine instrument group was unsatisfactory.

(i) Oil temperature and pressure warning light placards were obstructed by the landing light caution indicator glare shields.

(j) Doors were not jettisonable.

(8) Suitability of Internal Lighting. The USAARU evaluation (paragraph A, section two) is summarized as follows: "The cockpit and instrument panel illumination of this aircraft did not meet military standards for primary trainer capable of performing night training missions."

(9) Suitability of External Lighting. The position lights, located on the forward cross tubes of the landing gear skids were satisfactory. Reflections of the position lights from the polished aluminum main-rotor blades were distracting.

(10) Durability and Reliability. Durability and reliability could not be determined within the relatively short test time specified.

(11) Transportability. The helicopter is capable of being transported by C-123/130 type aircraft and by surface transport.

(12) Noise Level. The USAARU evaluation (paragraph A,

section two) is summarized as follows: "Internal and external sound pressure levels met the Statement of Requirement. However, numerous internal measurements exceed the Military Specification for acoustical noise levels in Army Aircraft."

b. Flight Characteristics. The helicopter was flown at gross weights up to the maximum certificated (1670 lb.). The following was determined:

(1) Stability. The stability of the helicopter was unsatisfactory for primary student training (see paragraph d below).

(2) Controllability. Controllability was unsatisfactory for primary student training (see paragraph d below).

c. Performance. The helicopter was flown at certificated gross weight (1670 pounds) and estimated mission operating weight (1580 pounds) to determine whether it met the performance criteria stated in the Model Specification. The following was determined:

(1) The helicopter was capable of cruising at 65 knots (TAS) at sea level.

(2) Endurance at 65 knots (TAS) was:

(a) 2.5 hours at 1670 pounds at density altitude of 1325 feet.

(b) 2.6 hours at 1580 pounds at density altitude of 1200 feet.

(3) Hover-out-of-ground effect was accomplished at a density altitude of 4400 feet which is equivalent to a pressure altitude of 1000 feet with an ambient temperature of 110° F. at mission operating weight. Hover-out-of-ground effect could not be accomplished at certificated gross weight (1670 pounds).

(4) The rates of climb under ICAO sea level standard day conditions at 43 knots TAS were:

(a) 1120 feet per minute at 1670 pounds.

(b) 1130 feet per minute at 1580 pounds.

(5) The autorotational performance was determined at 4400 feet density altitude (1000 feet pressure altitude, 110°F.) and at a true airspeed of 37 knots for maximum gross weight and estimated mission operating weight. Tested under these conditions, the rates of descent were:

(a) 1620 feet per minute at 1670 pounds.

(b) 1570 feet per minute at 1580 pounds.

(6) In autorotation under those conditions (paragraph (5) above), the helicopter regained rotor r.p.m. following a decay of rotor r.p.m. to the lower operating limit with an average of a 150-foot loss of altitude.

(7) The helicopter was capable of landing cross slope on 15-degree slopes.

(8) Rapid engagement of the clutch or power surges could dephase the blade dampers, producing a condition conducive to ground resonance.

d. Mission Suitability. This portion of the test was conducted by the USAPHS. Their report (paragraph B, section two) is summarized as follows: "The PH-9 is unsuitable for the training mission because of the following characteristics."

"(a) Sensitivity of the directional controls.

"(b) Lack of sufficient pedal control for recovery from student errors and inadvertent unusual attitudes.

"(c) The rate of movement to the point from which a safe recovery from unusual attitudes becomes difficult is exceedingly fast, thereby allowing insufficient latitude for instructor pilot corrections. The student is afforded little opportunity to correct his own mistakes.

"(d) The problems of directional control, insufficient pedal control, and latitude for student error are magnified by a cross-wind condition.

"(e) The rapid rotor decay after initial pitch application with subsequent reduction in directional control during touch-down autorotations leaves little margin for a safe recovery from student error.

"(f) Technique required for an autorotational touch-down are unacceptably critical for primary student training.

"(g) The rapid rotor decay, yawing to the left of approximately forty-five degrees, and attitude changes of the aircraft at power cut for a simulated forced landing leave no margin for student error. These require the instructor to advise the student in advance of the maneuver and heavily ride the controls, thus leading the student into the autorotational descent.

"(h) Any rapid application of throttle to join the needles or to apply power during ground operation, dephased the blade dampers inducing a condition conducive to ground resonance.

"(i) Trim controls and control locks are available only to the student pilot."

e. Maintenance.

(1) During the evaluation, the helicopter was maintained by the manufacturer's representative with military personnel provided for servicing, general assistance, and maintenance of records.

(2) Engine operation was trouble free when operated on standard Army aviation fuel (115/145 octane).

(3) The engine was not operated on standard Army aviation lubricants. (Detergent engine oil was used to coincide with commercial operation.)

(4) The helicopter was easy to service and maintain with the exception of oil servicing. All major components were readily accessible. During the test, replacement of one magneto was required.

(5) Tools and ground-support equipment normally found at the organizational level were adequate for organizational maintenance with the exception of special tools required for rephasing of

main-rotor-blade dampers. Special tools are required for higher echelons of maintenance.

2. Evaluation of Manufacturer's Technical Proposal. The manufacturer's technical proposal to configure the test helicopter to meet Model Specification was reviewed and the following was determined:

a. The landing light (ground adjustable) was satisfactory.

b. The proposed location and type of cyclic trim controls (longitudinal and lateral) were unsatisfactory. Trim controls were accessible from the student position only and required release of the collective pitch control to operate.

c. Required inertia reels for shoulder harnesses were not proposed.

d. Proposed electronic configuration was found to be satisfactory with the exception of the location of the C-1611 interphone controls which are not readily accessible from either the instructor or the student crew station.

e. Required floor-mounted and cyclic-control-mounted radio-interphone keying switches were proposed for both student and instructor pilot stations.

f. The proposal for a 24-volt electrical system was satisfactory. The alternate proposal for a 12-volt electrical system was unsatisfactory.

g. An attitude indicator was proposed.

h. A muff-type heater was proposed.

i. The USABAAR evaluation (paragraph C, section two) is summarized as follows:

"The evaluation considered the categories of Operational Safety, Maintenance Safety, and Crashworthiness. USABAAR considers this aircraft to be unacceptable as a primary helicopter trainer because of the high level of skill required to successfully perform an autorotation.

"Other areas which USABAAR considers as undesirable are contained in a full report." (See paragraph C, section two.)

j. The USAAHUMRU evaluation (paragraph D, section two) is summarized as follows:

"The design philosophy of the PH-9 was in large part guided by human factors considerations related to the primary helicopter training mission. As a result, the aircraft was found to be highly satisfactory from the human factors standpoint. Design decisions in large part appear to have been resolved in favor of the crew, maintenance personnel, or freedom from maintenance; rather than maximization of performance parameters.

"The major deficiencies noted were poor sideward visibility for tall personnel, and an unsatisfactory location for the C-1611 Intercommunication Set Control. In its proposed location the C-1611 Control would be dangerous due to its sharp edges, difficult to use, and difficult to see. Specification of this relatively large control is regarded as unrealistic for this compact helicopter, and it is recommended that any Army purchase specify that the contractor provide the applicable functions of these C-1611 Controls at the location of the presently installed Interphone-Transmit switch, which is quite satisfactory.

"Strong points were good visibility except as noted above, and good design from the standpoint of inspection and maintainability."

3. Comparison with Model Specification and Statement of Requirement. In determining whether the PH-9 met the requirements of the Model Specification and Statement of Requirement, the characteristics of the helicopter as tested and an evaluation of the manufacturer's technical proposal were considered.

a. Comparison with Model Specification as Amended.

| Mod. Spec. Para. No. | Model Specification as Amended | PH-9 Meets Spec. | Remarks |
|---|---|---|---|
| 1. | SCOPE. | | |

| Mod. Spec. Para. No. | Model Specification as Amended | PH-9 Meets Spec. | Remarks |
|---|---|---|---|
| 1.1 | Scope. This detail specification covers the essential requirements for the design of a single engine primary helicopter trainer capable of performing the mission specified in 1.2. | | |
| 1.1.1 | Designation and General Description. | | |
| | Army Model Designation - Primary Helicopter Trainer (Army Model Number not yet assigned) | | |
| | Number of Crew - 1 Pilot | Yes | |
| | Number of Passengers - 1 Student | Yes | |
| | Crew and Passenger Seating Arrangement - Side by side | Yes | |
| | Flight Controls - Dual | Yes | |
| | Type of Engine - Reciprocating | Yes | |
| | Main Rotor System - Single | Yes | |
| 1.2 | Mission. The primary Army mission for which the helicopter will be employed is training of military pilots in the basic operation and performance | No | See paragraph B, section two. |

| Mod. Spec. Para. No. | Model Specification as Amended | PH-9 Meets Spec. | Remarks |
|---|---|---|---|
| | of a helicopter. Training will be accomplished under conditions to which Visual Flight Rules apply. | | |
| 1.3 | Federal Aviation Agency Certification. The helicopter will have a Part 6 standard airworthiness certificate issued by the Federal Aviation Agency. | Yes | |
| 1.4 | Performance Information. Those items of performance stated as requirements herein which are not included in the FAA approved flight manual are subject to verification by the U. S. Army. | Yes | |
| 2. | APPLICABLE DOCUMENTS. | | |
| 2.1 | The documents applicable to this specification are those necessary to fulfill the requirements of paragraph 1.3, Federal Aviation Agency Certification. | Yes | |
| 3. | REQUIREMENTS. | | |
| 3.1 | Basic Weight. The basic weight of the helicopter will include all required installed equipment including the items of Paragraphs 3.7, 3.8.1.1, | Yes | |

| Mod. Spec. Para No. | Model Specification as Amended | PH-9 Meets Spec. | Remarks |
|---|---|---|---|
| | 3.8.1.2, and the Electronic Equipment as stated in Table E, Appendix I. | | |
| 3.2 | Center of Gravity Travel. Addition, removal or relocation of ballast or aircraft components will not be necessary in order to maintain the CG within CG limits due to changes in loading of the helicopter with respect to fuel, pilot and student. | Yes | |
| 3.3 | Useful Load. The useful load of the helicopter will be sufficient for 400 lbs. in addition to the fuel and oil necessary to accomplish the 2 1/2 hour endurance mission specified in paragraph 3.4.1. | Yes | |
| 3.4 | Required Performance. | | |
| 3.4.1 | ICAO Sea Level Standard Day Performance (at certificated gross weight). | | |
| | Cruise Speed (Minimum)- 65 knots | Yes | |
| | Endurance (Minimum) - 2 1/2 hours at 65 knots cruise speed. | Yes | |

| Mod. Spec. Para. No. | Model Specification as Amended | PH-9 Meets Spec. | Remarks |
|---|---|---|---|
| | Rate of Climb (Minimum)- 1000 ft. per minute | Yes | |
| 3.4.2 | Hovering Performance Requirement. At certificated gross weight the aircraft shall hover out of ground effect at 1000 feet at 110°F. | No | Helicopter hovered OGE at 4400 feet density altitude which is equivalent to 1000 feet pressure altitude at 110°F. at mission operating weight (1580 pounds). |
| 3.4.3 | Autorotation Characteristics (at certificated gross weight). | | |
| 3.4.3.1 | Normal Autorotation Speed. The manufacturer will designate a speed for normal autorotation not to exceed 45 knots. | Yes | |
| 3.4.3.2 | Rate of Descent. At the speed designated in 3.4.3.1 the helicopter will not exceed a stabilized autorotation rate of descent of 2200 feet per minute under conditions of 1000 ft. altitude and 110°F. | Yes | |
| 3.4.3.3 | Rotor R.P.M. Decay. In autorotation at the speed in 3.4.3.1 and conditions of 1000 ft. and 110°F, if rotor r.p.m. decays to the lower rotor r.p.m. limit, the helicopter will be capable | Yes | |

| Mod. Spec. Para. No. | Model Specification as Amended | PH-9 Meets Spec. | Remarks |
|---|---|---|---|
| | of regaining normal operating r.p.m. (as specified by the manufacturer) and with an altitude loss not to exceed 200 feet. | | |
| 3.5 | Aircraft Structure. | | |
| 3.5.1 | Landing Gear. | | |
| 3.5.1.1 | Type Landing Gear. Skid type landing gear which will permit running take-offs and landings. | Yes | |
| 3.5.1.2 | Slope Landings. The landing gear will permit cross slope landings on slopes of $15^{o}$. | Yes | |
| 3.5.1.3 | Ground Handling. Ground handling wheels are required. Weight of the ground handling wheels will not be included in the weight empty if they are detachable. | Yes | |
| 3.5.1.4 | Hoisting, Jacking and Mooring. Provisions will be made for hoisting, jacking and mooring. | Yes | |
| 3.5.2 | Main Rotor Blades. | | |
| 3.5.2.1 | Blade Interchangeability. The main rotor blades will be individually interchangeable. | Yes | |

| Mod. Spec. Para. No. | Model Specification as Amended | PH-9 Meets Spec. | Remarks |
|---|---|---|---|
| 3.5.3 | Control Pedals. Both sets of directional control pedals of the aircraft will be adjustable. | Yes | |
| 3.5.4 | Operating Environment. | | |
| 3.5.4.1 | Aircraft Operation. The aircraft will be capable of operating in temperatures from 0°F. to +100°F. | Undetermined | Temperatures during tests ranged from 75°F. to 95°F. |
| 3.5.4.2 | Cabin Heating. The aircraft will have a heating system which provides a minimum of 50°F. cabin temperature with 0°F. outside air temperature. This condition need only be satisfied with the engine operating. | Undetermined | Muff-type heating system proposed. Due to temperature ranges, this test could not be conducted. |
| 3.6 | Fuel and Lubricants. The engine will operate on such fuel and lubricants which are now established as standard by the US Army. (Ref: MIL G-5572C dated 12 Jul 60 & MIL L-22851 dated 30 Jun 61 & MIL L-6082C dated 18 May 61) | No | Engine oil required was not standard in the Army. Engine operated satisfactorily on 115/145 octane fuel. |
| 3.7 | Instruments and Navigational Equipment. Flight instruments and lights for day and night VFR conditions shall be furnished and installed by the contractor. | No | Instrument lighting unsatisfactory. See paragraph A, section two. |

| Mod. Spec. Para. No. | Model Specification as Amended | PH-9 Meets Spec. | Remarks |
|---|---|---|---|
| | An attitude indicator shall be provided as part of the basic aircraft instrumentation. | Yes | |
| 3.8 | Electrical. | | |
| 3.8.1 | Lighting. | | |
| 3.8.1.1 | Anti-Collision Light. The aircraft will have an anti-collision light. The light will be located to prevent reflection into the cockpit. | Yes | |
| 3.8.1.2 | Landing Light(s). The aircraft will be equipped with landing light(s) which will be adjustable. | Yes | |
| | The landing light switch will be located on the pilot's cyclic or collective control. | Yes | |
| 3.8.2 | Power Receptacle. The aircraft will be equipped with an external power receptacle of an AN or AMS standard Design. | Yes | |
| 3.8.3 | Switches and Auxiliary Controls. All switches and auxiliary controls necessary for flight and navigation will be accessible and within reach of the student pilot and the instructor pilot. Switches | No | Rotor-engage lever, cyclic friction controls, and cyclic trim controls were not available to the IP. Cyclic friction controls and cyclic |

| Mod. Spec. Para. No. | Model Specification as Amended | PH-9 Meets Spec. | Remarks |
|---|---|---|---|
| | and controls shall be operable in flight by personnel wearing winter flight clothing. Accessible floor mounted and cyclic control mounted radio-interphone switches will be provided for both student pilot and instructor. | | trim controls were difficult for the student to reach. The C-1611 control head was difficult to see and read. |
| 3.9 | Electronic Equipment. The aircraft will be equipped with the electronic equipment as indicated in appendix I. | Yes | |
| 3.10 | Safety Equipment. Seat belt and shoulder harness will be furnished for all occupants. | Yes | Seat belts and shoulder harnesses did not meet military specification. |
| | APPENDIX I | | |
| | Communication. | | |
| | UHF - AN/ARC 45, 1 ea. | Yes | GFE |
| | ICS - C-1611, 2 ea. | Yes | GFE |
| | Miscellaneous. | | |
| | Antenna - AT-450/ARC, 1 ea. | Yes | GFE |
| | Battery - Sonotone MA-7, 1 ea. | Yes | |
| | Inverter (If required either inverter listed will be a | Yes | Self-contained inverter was proposed |

| Mod. Spec. Para. No. | Model Specification as Amended | PH-9 Meets Spec. | Remarks |
|---|---|---|---|
| | suitable substitute for standard equipment.) - Leland MIL-E-93-200 or Bendix 328-172-1, 1 ea. | | with the attitude indicator. |

b. Comparison with Statement of Requirement. A comparison with the Statement of Requirement (reference 4) excluding those requirements covered by the Model Specification follows:

| Requirement | PH-9 Meets Requirement | Remarks |
|---|---|---|
| Size | | |
| It is desired that the external dimensions of the helicopter, less rotor, not exceed 8 feet in height, 23 feet in length, and 7 feet in width. | Yes | |
| With full cyclic movement, the rotor blade tip clearance above the ground level should not be less than 6 feet with rotors turning. | No | With cyclic centered and normal rotor r.p.m., ground-to-main-rotor clearance was satisfactory. |
| A minimum rotor diameter consistent with good autorotative characteristics is desired. | Yes | |
| Structure and Design | | |
| The following will be required: | | |
| Main rotor blades which are interchangeable, without retracking are desirable. | Yes | |

| Requirement | PH-9 Meets Requirement | Remarks |
|---|---|---|
| If more than two main rotor blades, provisions should be provided for simple expeditious folding and unfolding. | Yes | |
| It shall be free from ground resonance. | No | Fully-articulated rotor head was susceptible to ground resonance. |
| Suitable seat belt and shoulder harness for both student pilot and instructor. | No | Seat belts and shoulder harnesses did not meet Military Specification and inertia reels were not proposed. |
| Electrical | | |
| The following are required: | | |
| Lighting; adequate position, cockpit, anti-collision, and landing lights for night flight. Position and anti-collision lights to be positioned to prevent reflection into cockpit; landing light to be adjustable. | No | Position lights caused distracting reflection on main rotor blade. Cockpit lighting not satisfactory. Landing light specified in technical proposal will be ground adjustable. |
| Durability and Reliability | | |
| Engine and dynamic components should not be materially affected by dust, sand, moisture, etc., encountered in operation from unprepared areas. | Undetermined | |
| Noise Level | | |
| The lowest possible noise level | Yes | Exceeded Table I of |

| Requirement | PH-9 Meets Requirement | Remarks |
|---|---|---|
| is desired without use of a complex or elaborate muffler system or extension or heavy insulation. | | MIL-A-8806 (paragraph A, section two). |
| Personnel Considerations | | |
| No new personnel skills will be required. | Yes | Due to similarity of helicopter to other helicopters in Army inventory, no new skills will be required. |
| Training Considerations | | |
| No new training requirements will be generated. | Undetermined | Further evaluation in an actual training environment is required. |
| No supporting training devices other than those on hand at the US Army training base are required. | Yes | |

D. Deficiencies and Shortcomings.

1. The following deficiencies were noted during conduct of the test:

| Deficiency | Suggested Corrective Action |
|---|---|
| a. Directional control was unsatisfactory. | Decrease sensitivity of directional control. |
| b. Throttle and pitch correlation was unsatisfactory. | Improve throttle and pitch correlation. |
| c. Spring-loaded throttle with no override position was unsatisfactory. | Provide override position. |

| Deficiency | Suggested Corrective Action |
|---|---|
| d. Low inertia rotor system was unsatisfactory. | Increase rotor inertia. |
| e. Aircraft became unstable with inadvertent application of left pedal in autorotation. | Improve stability. |
| f. Crashworthiness was unsatisfactory. | Reference paragraph C, section two. |
| g. Rotor-engage lever was accessible from the student pilot station only and could not be operated from the instructor pilot station. | Relocate rotor-engage lever. |
| h. The engine could be started with the rotor-engage lever in the engage position. | Provide a system to prevent engagement with the rotor-engage lever in the "engage" position. |
| i. The location and proposed type of trim controls were unsatisfactory. | Provide suitable trim controls. |
| j. The location of cyclic friction controls was unsatisfactory. | Relocate cyclic friction controls. |
| k. Doors were not jettisonable. | Provide jettisonable doors. |
| l. Cockpit and instrument illumination did not meet military standards. | Provide illumination which meets military standards. |
| m. Proposed location of C-1611 interphone controls were unsatisfactory. | Relocate C-1611 interphone controls. |
| n. Inertia reels were not specified. | Install inertia reels. |

| Deficiency | Suggested Corrective Action |
|---|---|
| o. Seat belts and shoulder harness did not meet military specification. | Install seat belts which meet military specification. |
| p. Helicopter was susceptible to ground resonance. | Unknown. |
| q. A stop was not provided on the mixture control to prevent accidental fuel starvation. | Install stop on mixture control. |

2. The following shortcomings were noted during conduct of the test:

| Shortcoming | Suggested Corrective Action |
|---|---|
| a. No provisions were made for quick-disconnect of the battery. | Provide for quick-disconnect of battery. |
| b. Oil temperature and pressure warning light placards were obstructed by the landing light caution indicator glare shield. | Relocate the landing light caution indicator glare shield. |
| c. An ammeter measuring charge-discharge rates of the battery was provided in lieu of a load meter measuring the load on the generator. | Install load meter. |
| d. Engine exhaust presented a fire hazard in tall grass. | Provide adequate shielding. |
| e. Engine instruments group was unsatisfactory. | Provide satisfactory instruments group. |
| f. The airspeed indicator was sensitive to minor attitude. | Provide satisfactory airspeed indicator. |
| g. Pitch change push-pull rods were susceptible to damage if used as hand holds. | Placard pitch change push-pull rods. |

| Deficiency | Suggested Corrective Action |
| --- | --- |
| h. Magnetic chip detectors were not installed. | Install magnetic chip detectors of the continuous read-out type in the transmission and engine oil sumps. |

## SECTION TWO

### Reports from Other Agencies on the PH-9

PARAGRAPH A

Aviation Field Operations Division
U. S. ARMY AEROMEDICAL RESEARCH UNIT
Fort Rucker, Alabama 36362

USAARU-FO 23 September 1963

NOISE EVALUATION OF THE PH-9

1. Methods and Equipment.

a. Due to the number of aircraft to be tested and the short time available, the noise analysis was limited to the following:

(1) "A" - 24-55 db: sound level for speech interference.

(2) "B" - 55-85 db: sound level for noise survey.

(3) "C" - 85-140 db: sound pressure level--over-all frequency response.

b. A General Radio, Sound-Level-Meter, type 1551-C, was used for the noise measurements.

c. The test area, located at County Line Strip, is a premarked compass rose with a 50 foot radius.

2. Results. (See Annex A)

3. Discussion.

| | Doors On | Doors Off | MIL-A-8806 |
|---|---|---|---|
| Normal cruise | 113 | 113 | 106 |
| Maximum cruise | 112 | 113 | 113 |

a. Operation of this helicopter at normal cruise with the cockpit doors on or off produces internal sound pressure levels in excess of Table I MIL-A-8806.

USAARU-FO
SUBJECT: Noise Evaluation of the PH-9

23 September 1963

b. Operation of this helicopter at maximum cruise with the doors on or off produces internal sound pressure levels which meet the limits set by Table IV MIL-A-8806.

c. There are no military specifications for external noise. Raw data is included for comparison purposes only.

4. Summary. Improvements should be made to reduce noise levels when operating at normal cruise in order to meet military specification (MIL-A-8806).

1 Incl
as

/s/ William C. Thrasher
/t/ WILLIAM C. THRASHER
1/Lt., MSC
Ass't Chief, Avn Fld Opns Div

NOISE LEVEL MEASUREMENTS - OCTAVE BAND ANALYSIS

DATA COLLECTION SHEET

Analyzed by Lt W. C. Thrasher
SFC Lonnie Parsons

Date 20 Sep 63

PH-9

| DOORS-ON | A | B | C | Center | Student | Air Speed | Mani-fold | RPM | Radius |
|---|---|---|---|---|---|---|---|---|---|
| Ground idle | 93 | 101 | 109 | | | | 12.5" | 2000 | |
| Ground high power | 98 | 104 | 109 | | | | 15.5 | 2900 | |
| Hover | 101 | 105 | 110 | | | | 25 | 2900 | |
| Normal cruise | 102 | 106 | 113 | | | 70 mph | 24 | 2900 | |
| Maximum cruise | 103 | 108 | 112 | | | 86 mph | 27.5 | 2900 | |
| DOORS-OFF | | | | | | | | | |
| Ground idle | 95 | 108 | 116 | | | | 12.5 | 2000 | |
| Ground high power | 100 | 107 | 112 | | | | 15.5 | 2900 | |
| Hover | 103 | 110 | 115 | | | | 25 | 2900 | |
| Normal cruise | 101 | 108 | 113 | | | 70 mph | 24 | 2900 | |
| Maximum cruise | 102 | 108 | 113 | | | 86 mph | 27.5 | 2900 | |
| EXT HIGH POWER | | | | | | | 15.5 | 2900 | 50' |
| (RIGHT) 0 | 96 | 96 | 99 | (LEFT) 0 | 91 | 96 | 99 | | |
| 30 | 90 | 94 | 97 | 330 | 92 | 97 | 100 | | |
| 60 | 90 | 94 | 97 | 300 | 91 | 94 | 97 | | |
| 90 | 91 | 95 | 99 | 270 | 92 | 95 | 98 | | |
| 120 | 95 | 98 | 100 | 240 | 94 | 98 | 101 | | |
| 150 | 97 | 101 | 103 | 210 | 96 | 101 | 104 | | |
| 180 | 96 | 101 | 105 | 180 | 96 | 101 | 105 | | |
| HOVER | | | | | | | 25" | 2900 | 50' |
| (RIGHT) 0 | 93 | 96 | 97 | (LEFT) 0 | 93 | 96 | 97 | | |
| 30 | 95 | 96 | 98 | 330 | 94 | 97 | 99 | | |
| 60 | 94 | 97 | 101 | 300 | 94 | 98 | 101 | | |
| 90 | 97 | 99 | 101 | 270 | 98 | 100 | 103 | | |
| 120 | 102 | 102 | 105 | 240 | 102 | 103 | 107 | | |
| 150 | 104 | 107 | 110 | 210 | 104 | 107 | 109 | | |
| 180 | 101 | 105 | 109 | 180 | 101 | 105 | 109 | | |

EXHAUST OUTLET RIGHT SIDE OF AIRCRAFT

Aviation Field Operations Division
U. S. ARMY AEROMEDICAL RESEARCH UNIT
Fort Rucker, Alabama 36362

USAARU-FO 23 September 1963

# LIGHT EVALUATION OF THE PH-9

1. Methods and Equipment.

a. The evaluation consisted of in-flight analysis of the aircraft's lighting system under night conditions. Criteria for this evaluation were derived from U. S. Navy Specifications governing cockpit and instrument panel illumination modified to meet Army requirements.

b. A standard Norwood photo-electric meter was used to measure over-all cockpit illumination from the auxiliary hand light or map light.

2. Results. (See Annex A)

3. Discussion.

a. Luminous paint and ultraviolet light used to illuminate instrument dials and gauges afford adequate light intensity but impair visual acuity. The extreme contrast between the black, light absorbing background of the dials and the luminous markings can cause discomfort and distraction to an inexperienced aviator.

b. The airspeed indicator, the rotor tachometer, the altimeter and the manifold pressure gauge were unreadable at night due to the position of the flight instrument panel.

c. When the instrument panel lights were adjusted to adequately illuminate the instruments, a great amount of light was reflected from the bubble into the pilot's eyes. With the instrument panel lights turned off, a complete panel of luminous dials and gauges was reflected in the bubble.

d. An auxiliary light or map light should be placed in the cockpit to aid in navigation and to furnish light in case of electrical failure of the instrument panel lighting circuit.

USAARU-FO 23 September 1963
SUBJECT: Light Evaluation of the PH-9

4. Summary. At present the cockpit and instrument panel illumination of this aircraft does not meet the military standards for a primary or instrument trainer capable of performing night training missions.

/s/ William C. Thrasher
/t/ WILLIAM C. THRASHER
1/Lt., MSC
Ass't Chief, Avn Fld Opns Div

1 Incl
as

Aviation Field Operations Division
U. S. ARMY AEROMEDICAL RESEARCH UNIT
Fort Rucker, Alabama

COCKPIT LIGHT STUDY
PH-9

1. Are all instruments adequately illuminated? No (Note para 3a)

2. Are they illuminated uniformly? No (Note para 3b) Is there sufficient intensity? No

3. Is illumination controllable to very low intensities? Yes (Aperature Change)

4. Are markings of instruments readable? No (Note para 3b)

5. Are all controls, instructions, and nameplates adequately illuminated? No

6. Are they illuminated uniformly? No Is there sufficient intensity? No

7. Is illumination controllable to very low intensities? No (Note para 3c)

8. Are markings on controls, instructions and nameplates readable? No

9. Is the intensity of lighting for some instruments and controls controlled separately? No

10. Is an auxiliary light provided? No Is the light standard red? N/A

11. Is the power source independent of normal lighting circuit? N/A

12. Are there any sources of light which give other than standard red light? Yes

13. Are there any reflections in the windshield, windows, canopy or other reflecting surfaces which interfere with visibility inside or outside the cockpit? Yes (Note para 3c)

ANNEX "A"

14. Is there light leakage into the cockpit from other compartments? N/A

15. Are spare lamps provided in sufficient quantity and easily accessible? No

16. Are all instruments, instructions, nameplates, and control markings readable in daylight? Yes

17. Can warning and caution lights be dimmed sufficiently for night operations? No (Landing light indicator could not be dimmed.)

18. Are warning and caution lights of sufficient intensity for daylight use? Yes

19. Are warning and caution lights on the main dimming circuit? No

20. Is lighting provided in accordance with the aircraft detail specification? N/A

21. Is the auxiliary light adequate for reading? No

22. Does the light cause glare to cockpit? N/A

23. Is there adequate general illumination for the compartment? No (Note para 3d)

24. Do any of the exterior lights provide glare in the cockpit? Yes

25. Is exterior lighting provided in accordance with FAA? Yes

Aviation Field Operations Division
U. S. ARMY AEROMEDICAL RESEARCH UNIT
Fort Rucker, Alabama

USAARU-FO

25 June 1963

REPORT ON PH-9

1. Method of Testing.

a. The heating and ventilation evaluation of the PH-9 consisted of comparisons of outside air temperature and cockpit air temperature with the aircraft under all operating conditions. In conjunction with these checks, a carbon monoxide test was also made.

b. Equipment consisted of:

(1) Weston Anercid Thermometer, Model 2291.

(2) Mine Safety Appliance Company Carbon Monoxide Tester, Category No. DS-47133.

2. Results. (See Annex A)

3. Discussion.

a. Although reasonably high temperatures were encountered on the aircraft with doors on, windows closed and vents closed (see Annex A), it is felt that this aircraft will rarely be operated under those conditions with existing outside temperatures in the 90°F. range.

b. The recommended maximum temperatures for clothed men not especially acclimatized are as follows:

(1) Resting in still air - 88°F.

(2) Resting, with some air movement (170 FPM air velocity - 93°F.

(3) Moderate work, still air - 78°F.

Reference: Patty, Frank A., Industrial Hygiene & Toxicology (2d ed., Vol. 1; New York: Interscience Publishers Inc., 1958).

c. Comparing recommended working temperatures (see above) with temperatures found in aircraft (see Annex A), a mean working temperature of 90°F. was derived. This is felt to be within limits.

d. A small percentage of carbon monoxide (.01) was found in the aircraft with the doors on, windows closed, vents closed, and the aircraft on the ground at operating RPM. This amount is not felt to be significant and rarely will the aircraft be operated on the ground with doors on, windows closed, and vents closed.

e. A heater was not present on this aircraft.

/s/ J. C. Rothwell
/t/ J. C. ROTHWELL
Captain, MSC
Ass't Chief, Avn Fld Opns Div

1 Incl
as

PH-9

## HEATING AND VENTILATION EVALUATION OF OFF-THE-SHELF HELICOPTER TRAINERS

Analyzed by Capt. Rothwell Date 14 June 1963

| | % CO | | Temp | |
|---|---|---|---|---|
| | A/C | Out | A/C | Out |
| VENTILATION | | | | |
| On Ground | | | | |
| Doors Off (P) | 0 | 0 | 94°F | 90°F |
| Doors On - Window Closed, Vent Open | 0 | 0 | 96°F | 90°F |
| Doors On - Window Closed, Vent Closed | 0 | 0 | 98°F | 90°F |
| Hover | | | | |
| Doors Off (P) | 0 | 0 | 92°F | 90°F |
| Doors On - Window Closed, Vent Open | 0 | 0 | 94°F | 90°F |
| Doors On - Window Closed, Vent Closed | .01 | 0 | 96°F | 90°F |
| In-Flight | | | | |
| Doors Off (P) | 0 | 0 | 90°F | 87°F |
| Doors On - Window Closed, Vent Open | 0 | 0 | 92°F | 82°F |
| Doors On - Window Closed, Vent Closed | 0 | 0 | 94°F | 82°F |

HEATING*

*Heater not present on this aircraft.

ANNEX "A"

PARAGRAPH B

HEADQUARTERS
UNITED STATES ARMY PRIMARY HELICOPTER SCHOOL
Fort Wolters, Mineral Wells, Texas

AKPWO-HS 30 September 1963

SUBJECT: Evaluation of Mission Suitability of the Primary Helicopter Trainer (Off the Shelf) USATECOM Project No. 4-3-1000-01-A

TO: President
US Army Aviation Test Board
Fort Rucker, Alabama

Attached hereto are reports of evaluation of mission suitability for the PH-6, PH-7, and PH-9 Helicopters.

/s/ J. E. Gonseth, Jr
/t/ J. E. GONSETH, JR
Colonel, Signal Corps
Commandant

3 Incls
1. PH-6
2. PH-7
3. PH-9

## PARAGRAPH B

## EVALUATION OF MISSION SUITABILITY

## OF THE

## PH-9 HELICOPTER AS CONDUCTED BY THE

## UNITED STATES ARMY PRIMARY HELICOPTER SCHOOL

1. Scope. Experienced primary flight instructors from the US Army Primary Helicopter School conducted primary flight training with qualified student officers with no previous flight experience and transition training for rated Army aviators with varied experience in observation helicopters. The helicopter was repeatedly flown through typical training missions with the students being required to perform maneuvers included in the approved flight syllabus of the US Army Primary Helicopter School, Fort Wolters, Texas.

2. Findings.

a. Hovering.

(1) The student pilot is unable to adjust the cyclic trim control while at a hover due to the fact that he must release the collective pitch control with the left hand to make the required adjustments. The instructor pilot could not make any adjustments as the controls are located out of his reach. This precludes the instructor demonstrating the correct inflight trim application to the student. Although the control forces can be overridden by the pilot, prolonged operations with an out-of-trim condition becomes irritating and tiresome to the beginner aviator and detracts from the learning process.

(2) Directional control is unacceptably sensitive for primary student training. The normal tendency of the student pilot to be late in correcting for errors and to overcontrol when corrective action is taken resulted in see-sawing action in all hovering work.

(3) Sufficient pedal control action was lacking at times for proper recovery from student errors and inadvertent unusual attitudes.

(4) The rate of movement to the point from which a safe recovery from unusual attitude can be made is reached exceedingly

d. Running Take-Off and Landings.

(1) Directional control is unacceptably sensitive for primary student training as the helicopter taxied over the ground, as it broke ground on take-off and upon ground contact and ground run during the landing.

(2) The action of the oleo struts contributes to the problem of directional and cyclic control on take-offs and landings. During a crosswind take-off, application of cyclic control into the wind depresses the upwind oleo and causes the downwind skid to lift off the ground. Prior to reaching translational lift, the limit of directional control is reached and the pilot is unable to compensate for the unequal skid drag condition. Inadvertent landing on one skid causes an unequal oleo action and skid drag, creating an area of pedal and cyclic action that is beyond the primary student's ability.

e. Hovering Autorotations.

(1) Low inertia rotor system imposes the need for exceptional skill and timing by the pilot. Yaw control and collective pitch application must be perfectly timed. This requirement for such precision is unacceptable for primary student training.

(2) In teaching this maneuver to a student, the instructor pilot would be required to accept an inordinate amount of risk during the "IP hands off" stage. There is little or no margin for error.

(3) Power recoveries from hovering autorotations were not attempted because of the characteristic of the blade dampers to dephase at power surge.

f. Autorotations.

(1) Day and night autorotational landings were performed. This aircraft required a low flare of approximately twenty feet altitude with initial pitch application being made at approximately three feet, with a continuous application until ground contact. The main rotor RPM decayed at a rapid rate after initial pitch application with subsequent reduction in directional control on landing runout. The flare altitudes, amount of flare, and altitude and amount of initial pitch application are unacceptably critical for primary student training due to the low inertia rotor system with a rapid rate of main rotor RPM decay at pitch

fast, thereby allowing insufficient latitude for instructor pilot corrections.

(5) The problems of directional control, insufficient pedal control and latitude for student error are magnified by a crosswind condition.

(6) Pilot posture due to seat and control relationship is very fatiguing.

b. Normal Take-Off and Normal Approach.

(1) Directional control is unacceptably sensitive for primary student training as the helicopter moved through effective translational lift into forward flight and upon termination of the approach to a hover. A crosswind condition of 8-15 knots magnified the problems of directional control to the point where the primary student could not safely control the helicopter during the approach and termination. Considerable effort is required by the instructor to safely control the aircraft under similar conditions.

(2) The problem of directional control causes overcontrolling of other controls while trying to maintain a heading or to correct a heading error.

(3) The airspeed indicator is unacceptably sensitive to minor attitude changes.

c. Maximum Performance Take-Off and Steep Approach.

(1) Directional control is unacceptably sensitive for primary student training during transition to normal climbing power after a maximum performance take-off and during the termination of the steep approach to a hover. A crosswind condition of 8-15 knots magnified the problem of directional control to the point where the primary student could not safely control the aircraft during take-off, approach, and approach termination to a hover. Considerable effort is required by the instructor to control the aircraft under similar conditions.

(2) The aircraft has a tendency to weathercock during a maximum performance take-off in crosswind conditions. Inadvertent slow airspeed at this point of the take-off results in insufficient pedal control to prevent the helicopter from going into uncontrollable turns during climb-out.

application. The aircraft is not forgiving at this critical point of the maneuver and affords the instructor pilot little leeway for corrective action after normal student errors. The requirement for a low flare at approximately twenty feet of altitude with initial pitch application for cushioning the landing required at approximately three feet of altitude develops such a rapid series of events that the primary student would be unable to learn the required touchdown techniques within the prescribed time. The rapid decay of main rotor RPM after the initial application of collective pitch requires that the altitude of initial application be exact. The precision required at this critical point of the autorotation is such that there is little or no margin for error and dictates that the instructor pilot must ride the controls heavily at all times, thus continually leading the student through all control applications. This would greatly reduce the effectiveness of the Primary course. A requirement for a power recovery due to student error at initial pitch application induces such a rapid series of events that the pilot is unable to maintain heading, regain operating rotor and engine RPM and return the aircraft to safe flight conditions.

(2) The autorotative characteristics outlined above are unacceptable for primary student training. They would be very detrimental to the student's mental composure and would adversely affect the learning process.

g. Simulated Forced Landings.

(1) The normal student delay in reducing the collective pitch to the full-down position and in making proper application of right pedal for torque control in response to a power cut caused the main rotor RPM to decay below the lower safe limit of 400 RPM. No margin for student error is available. An inadvertent application of left pedal at power cut, an error not uncommon with primary students, causes the aircraft to start an immediate tumbling roll towards the left front. Full right and full aft cyclic control combined with an immediate power recovery are required to recover from this unusual attitude.

(2) The loss of main rotor RPM and yawing to the left of approximately forty-five degrees at power cut would, for reasons of safety, require the instructor pilot to advise the student in advance of the maneuver and to then heavily ride the controls, thus leading the student into the autorotational descent. This procedure would have to be continued throughout the course of instruction due to the inability of the students to react quickly enough to the required control inputs

necessary to counteract the rapid changes of aircraft attitude and RPM loss. This would greatly reduce the effectiveness of the Primary Course.

(3) All of the autorotative touchdown characteristics listed under autorotations are unacceptable for primary student training during the teaching of simulated forced landing touchdowns.

h. Decelerations. Yaw control is unacceptably sensitive for primary student training.

i. Simulated Anti-Torque Control Failure. Low inertia rotor system imposes the need for exceptional skill and timing by the pilot. Yaw control at entry to the maneuver and collective pitch application must be perfectly timed. This requirement for such precision is unacceptable for primary student training.

j. General.

(1) The clutch engagement cable is routed under a lead acid battery.

(2) The exhaust stacks are located on the bottom of the aircraft near the fuel drains constituting a fire hazard during confined area operations.

(3) The pilot is unable to check the oil level between flights without long delay because the oil dip stick handle is too hot to touch.

(4) Any rapid application of throttle to join the needles or to apply power dephased the blade dampers inducing a condition conducive to ground resonance. Dephased blade dampers induced a severe vibration during descending powered flight and autorotative descent.

(5) The control trims and control locks are available only to the student pilot.

(6) The clutch hand lever is completely out of the instructor's reach and he is entirely dependent upon the student for clutching and de-clutching. Rapid engagement of clutch will dephase the blade dampers, inducing a condition conducive to ground resonance or blade damage.

(7) This aircraft moves so rapidly into an extreme condition after a student induced error that the instructor pilot must maintain an extremely high level of alertness. This makes flight instruction in the aircraft exceptionally tiring and creates a feeling of tension during the flight that is detrimental to the presentation of instruction.

(8) The placement of the flight instruments does not coincide by association with the flight controls. This is detrimental to a good cross check. The RPM gage, associated with the pilot's left hand and arm, is located on the right side of the console. The airspeed indicator, associated with the pilot's right hand and arm, is located on the left side of the console.

(9) The collective pitch and throttle, when not frictioned, creep in flight and the engine RPM will drop 300 RPM or more in a fraction of a second if the pilot attempts to tune the radio, set trim, or make any other adjustments requiring the removal of his left hand from the collective pitch control.

3. Comparison with Criteria for Evaluation of Mission Suitability of "Off the Shelf" Primary Trainers. A comparison of the characteristics of the helicopter with the Criteria for Evaluation follows:

| Criteria for Evaluation | Helicopter Meets Criteria | Remarks |
|---|---|---|
| Flight Controls (Cyclic, collective and anti-torque): Must have a rapid response with no tendency to overshoot in response to corrections in powered and non-powered flight due to the general inability of the student pilot to treat any aircraft with the same finesse and care of a seasoned pilot. | No | See para 2 a, b, c, d, e, and g. |
| Stability: Inherent stability in the vertical, longitudinal and lateral axis that will absorb power changes (Power to non-power, non-power to power, intentional/inadvertent) with minimum corrective action required to regain positive control. | No | See para 2a, b, c, d, e, f, g, h, i, and j. |

| Criteria for Evalution | Helicopter Meets Criteria | Remarks |
|---|---|---|
| Power Reserve: Provide an adequate power reserve that will allow the instructor pilot to contain or recover from unusual situations induced by student errors. | Yes | |
| Autorotative Characteristics: Rotor mass and inertia adequate to allow for student error in autorotative landings. | No | See para 2e, f, g, and i. |
| Latitude for Student Error: Inherent flight characteristics that will allow a student to make an identifiable error and still have sufficient latitude for the student pilot and/or instructor pilot to make a recovery. No preflight or starting techniques that would demand detailed procedure or unusual knowledge on the part of the student and instructor pilot. | No | See para 2a, b, c, d, e, f, g, i, and j. |
| Training Endurance Considerations: Adequate ventilation, heating and defrosting equipment. Ample shoulder room between IP and student, and between collective and door. Comfortable seat cushions to allow four hours of flight without undue fatigue. | No | See para 2a(6) and j(7). |
| Location of Controls: Trim controls if required on each cyclic stick. Any control or safety devices in sight and reach of IP. | No | See para 2a(1) and j(5) (6). |
| Ground Resonance: Must be free from ground resonance. | No | See para 2e(3) and j(4) (6). |

4. Conclusion: The PH-9 is unsuitable for use as a Primary Helicopter Trainer.

PARAGRAPH C

BAAR-P 30 September 1963

SUBJECT: USABAAR's Evaluation of PH-9 Off-the-Shelf Primary Helicopter Trainer

TO: President
U. S. Army Aviation Test Board
ATTN: Off-the-Shelf Project Officer
Fort Rucker, Alabama

1. The following is USABAAR's evaluation of the PH-9 entry for the off-the-shelf primary helicopter trainer competition. The evaluation considered the categories of aviation safety and accident prevention in three primary categories. In each of these categories, there are certain deficiencies which will detract from its mission capability and should be considered by those responsible for selecting the winner of the competition. Categories considered are:

a. Operational Safety - This category considers those features of the aircraft and its operating characteristics that are considered to be conducive to accident causation and which may detract from the operator's ability to maintain safe flight at all times.

b. Maintenance Safety - This category considers maintenance design features of the aircraft contributing to accident causation. It includes those features of "Murphy's Law," ease of inspection, accessibility for component replacement, the preflight inspection imposed on the operator, etc.

c. Crashworthiness - This category considers design features of the aircraft that, in the event of a crash, provide protection to the occupants from injury. It also includes features of crash-fire worthiness.

2. Evaluation comments are as follows:

a. Operational Safety

(1) Clutch engagement - No provisions are included to prevent starting the engine with the clutch engaged to prevent damper and rotor head damage.

(2) Engine instrument group - The mounting angle of the instruments makes readout difficult.

(3) Intercom system - A two position ICS/Transmit switch should be located on the cyclic control to preclude the need to remove hands from control grip in event of emergency.

(4) Pilot distraction and loss of visibility - The instruments are mirrored in the bubble during day and night. The light angle and the reflection characteristics of the bubble are such that during night and day operations, the instrument panel is noticeably visible in the bubble.

(5) Navigation lights - The light positioned above the bubble creates detracting reflections on the bubble at night. The modification that relocates the lights on the skid assembly appears to be more satisfactory.

(6) Instruments - Instrument legibility becomes blurred and difficult to read at night when using the landing light during final approach and hover. This deficiency is particularly noticeable when the instrument light is partially dimmed.

(7) Map light - There are none installed or proposed. Map lights should be installed to preclude the use of makeshift lights.

(8) Landing light - The fixed landing light causes excessive glare on the bubble when operating close to the ground.

(9) Transmission and pressure warning lights - The labels of these displays are not visible to the pilot.

(10) Engine exhaust - It is located approximately 15 inches from the ground and acts as an ignition source when operating in areas of tall dry grass.

(11) Skid Shoe - The short skid shoe installation exposes skids to catching on ground objects. Installation of full length skid shoes is required to preclude snagging ground objects.

(12) Autorotation characteristics - The autorotation characteristics are such that more skill is required to perform this maneuver than is presently needed in any other helicopter presently in the Army inventory. USABAAR is of the opinion that this factor alone would make this helicopter unacceptable as a primary trainer.

(13) Cyclic control - Upon entering autorotation an unusually excessive amount of aft cyclic control is necessary to maintain desired air speed.

(14) Cyclic trim control - When flying at or near gross weight, there is insufficient amount of forward cyclic trim to alleviate control pressures.

b. Maintenance Safety

(1) *Pitch change push-pull rods* - *The pitch change push-pull* rods from the lower bell cranks to the main rotor system are susceptible to damaging lateral loads when used as hand holds. Their accessibility makes the occurrence very likely.

(2) Magnetic chip detector - Install magnetic chip detectors of the continuous readout type in the transmission and engine oil sumps.

c. Crashworthiness

(1) Seat pan - Energy absorption in the vertical direction appears to be unsatisfactory. This is based on the amount of space available before the seat pan "bottoms out."

(2) Seat back rest

(a) The space behind the back rest is accessible for the storing of odd items such as clipboards, tools, handbooks, etc. These items can contribute to crash injury.

(b) The energy absorption qualities of the thermoplastic material are unknown as to the extent they may protect against injury.

(3) Cyclic control - The design and position of the cyclic control makes it lethal in the production of injury.

(4) Shoulder harness and inertia reel - Any aircraft procurement must include these items to be acceptable to USABAAR.

(5) Seat belt - The attaching point is not self-aligning in all directions which makes it vulnerable to failure when lateral loads are applied.

(6) Cockpit integrity - The cockpit lacks structural members that will prevent impingement upon the occupants in the event of a crash.

(7) Fuel cell - The cell design is susceptible to rupture. Its immediate proximity to ignition sources creates a post-crash fire hazard.

3. The following features are recognized as desirable and considered worthy of mention:

a. Cyclic and pitch control forces are negligible.

b. The range of external vision from the cockpit is excellent.

c. The throttle and pitch controls are well correlated.

d. The design and the inspection requirements of this aircraft makes it easy for the pilot to perform his preflight.

e. The landing gear design was found to have some outstanding characteristics. Forces applied to the landing gear during hard landings are not transmitted to the basic airframe structure; thus, eliminating main rotor blade flexing.

/s/ Robert M. Hamilton
/t/ ROBERT M. HAMILTON
Colonel, Infantry
Director, USABAAR

## PARAGRAPH D

U. S. ARMY AVIATION HUMAN RESEARCH UNIT
Fort Rucker, Alabama

9 October 1963

Human Factors Evaluation: PH-9 Helicopter

1. Summary

1.1 The design philosophy of the PH-9 was in large part guided by human factors considerations related to the primary helicopter training mission. As a result, the aircraft was found to be highly satisfactory from the human factors standpoint. Design decisions in large part appear to have been resolved in favor of the crew, maintenance personnel, or freedom from maintenance; rather than maximization of performance parameters.

1.2 The major deficiencies noted were poor sideward visibility for tall personnel, and an unsatisfactory location for the C-1611 Intercommunication Set Control. In its proposed location the C-1611 Control would be dangerous due to its sharp edges, difficult to use, and difficult to see. Specification of this relatively large control is regarded as unrealistic for this compact helicopter, and it is recommended that any Army purchase specify that the contractor provide the applicable functions of these C-1611 Controls at the location of the presently installed Interphone-Transmit switch, which is quite satisfactory.

1.3 Strong points were good visibility except as noted above, and good design from the standpoint of inspection and maintainability.

2. Detailed Considerations

2.1 Handling characteristics were regarded as generally satisfactory, with no major problems from the human factors standpoint.

2.2 Visibility was generally good.

2.2.1 View of instruments was good.

2.2.2 Forward and rearward visibility was good.

2.2.3 Downward visibility was satisfactory except for lack of view of the skids. Skid view is not of major importance for experienced pilots, but is of value for student orientation. If the PH-9 should be purchased, probably a skid reference would be improvised by attaching a stiff but yielding (like steel auto curb feelers or rubber goal line flag masts) extension to the skid.

2.2.4 Sideward visibility was good except for tall personnel. Sideward visibility at flight level will be poor for pilots above the 95th percentile in seat to eye height with the doors off, and down to about the 85th or 90th percentile with the doors on. Visibility is restricted more on the near side than on the far side. No seat adjustment is provided which would permit the eyes of tall individuals to be located at a level where satisfactory sideward visibility could be obtained.

2.3 Glare shields on the "Landing Light On" signal light and the "Transmission Oil Temperature and Pressure" warning signal lights mask their labels. The shield should be redesigned for the Transmission Oil Temperature and Pressure warning lights with the labels placed on it in a manner visible from both crew stations. The labels should be placed so that illumination of the indicator light will provide illumination of the appropriate label, or else the label should be placed on the lens of the indicator.

2.4 The "Landing Light On" indicator uses a red lens, which should only be used to indicate a dangerous situation requiring immediate action. A green or white lens should be used on this indicator. This is particularly advisable since a red indication could easily be confused with the adjacent transmission oil warning signals, or the transmission oil warning signals not noticed. Consideration should be given to eliminating the "Landing Light On" indicator.

2.5 The engine status indicators do not conform to desirable practices of arranging these in a way that indicates "OK" when they are aligned, but the present arrangement requiring separate reading of each indicator is considered preferable over an alignment scan arrangement. This is due to the fact that operational Army aircraft will all require separate reading of these indicators. When most operational Army aircraft employ alignment scan status indicators, then it would be desirable for the primary trainer to also incorporate this arrangement of indicators.

2.5.1 The arrangement of the Fuel Quantity, Amperes, Fuel Pressure, Cylinder Head Temperature, Engine Oil Pressure, and Engine Oil Temperature indicators used is regarded as less than optimum. Switching the locations of the Engine Oil Temperature and Amperes indicators would be desirable.

2.5.2 The safe operating ranges of the Fuel Pressure, Cylinder Head Temperature, Engine Oil Temperature, and Engine Oil Pressure indicators are not easily determined under night instrument panel illumination. It is recommended that green and yellow operating range arcs be placed on these indicators with the same materials and widths as are used on the Engine-Rotor R.P.M. indicator.

2.6 During night operation minor reflections were noted from cockpit lighting or tail boom rotating beacon. However, these were not regarded as of concern for the intended night use of the primary helicopter trainer.

2.7 Dual trim controls are not provided. Trim controls for the left seat would be desirable when the instructor occupies this position. Quick adjustment of trim cannot easily be accomplished from the left seat while also controlling the helicopter. Linked trim controls permitting left handed trim adjustment from the left seat would be desirable.

2.8 The proposed location of the C-1611 Intercommunication Set Control was not satisfactory for the listed reasons.

2.8.1 The sharp edges of the C-1611 Control would present a hazard to both occupants.

2.8.2 The control would be difficult to see in the proposed location, and the head twisting required to see it would invite vertigo.

2.8.3 The control would be difficult to reach, particularly while wearing winter clothing.

2.8.4. A satisfactory alternate location for the C-1611 Controls could not be found.

2.8.5 The specification of the relatively large C-1611 Controls for this compact helicopter is regarded as unrealistic. All required functions of this control could easily be provided in a much smaller package which could be appropriately located.

2.8.6 It is recommended that any purchase of this helicopter specify that the contractor provide the applicable functions of the C-1611 Control, placing the controls at the panel level used for the "Intercom-Transmit" switch of the evaluated aircraft.

2.8.6.1 The specified controls could be placed outside the cockpit, and the applicable controls wired to operate at the panel level used for the "Intercom-Transmit" switch of the evaluated aircraft, but this is not considered desirable.

2.8.6.2 It is believed that the contractor could provide the required functions at less cost than that of the C-1611 Intercommunication Set Control.

2.9 It was noted that the rear side of the tilting seat back separated from the forward side at the rivet points. A stronger material, better attachment, or a single mould is recommended to prevent this separation.

2.10 The tinted bubble panels above and behind the crew positions are desirable as a means of reducing radiation and temperatures imposed on the crew during hot weather.

2.11 The plastic used for the seat back could be uncomfortable when sweating under hot conditions. Consideration should be given to perforating this plastic in order to provide some ventilation of the back, providing structural properties are not impaired.

2.12 The heater installation appears to be capable of providing adequate heat and bubble de-fogging.

2.13 The anti-torque pedals are designed in a manner that might permit their edge to hook under the instrument panel plastic cover at the side seam. Screws working out at the seam, the flat straight edge of the pedal, and the shortest pedal position of the four proposed, could combine to make forward inside pedal movement impossible.

2.13.1 Either the position of the seam should be moved well aft of maximum pedal deflection, or else the edge of the pedal should be designed to preclude catching on this seam.

2.14 The aircraft is outstanding from the standpoint of inspection and maintenance. The design minimizes the frequency and number of required lubrication and maintenance operations. Visibility of and access to components is very good, and the design facilitates most maintenance operations.

2.14.1 The engine oil level dipstick and filling hole are difficult to reach. A special device for adding oil is listed as an available part, and is needed. A permanently-mounted device extending both the dipstick and filling hole to an accessible position is desirable.

2.14.2 Changing the position of the ground handling wheels requires two men. A tool could be designed to enable one man to accomplish this, and should be considered.

/s/ Robert H. Wright, Ph.D.
/t/ ROBERT H. WRIGHT, Ph.D.
Research Scientist

## PART III - APPENDICES

# APPENDIX A

UNITED STATES ARMY AVIATION SCHOOL
OFFICE OF THE COMMANDANT
FORT RUCKER, ALABAMA 36362

AJRCG 8 November 1963

SUBJECT: Report of Test, USATECOM Project No. 4-3-1000-01-A, Military Potential Test of Commercial "Off-the-Shelf" Helicopters as Primary Helicopter Trainers

TO: President
U. S. Army Aviation Test Board
Fort Rucker, Alabama

1. I have reviewed the final draft of the subject report of test and reconfirm my oral concurrence with the findings, conclusions and recommendations contained therein.

2. While I am fully aware that the responsibility for the primary helicopter training mission is that of the Army Primary Helicopter School rather than the Aviation Center, I have a deep appreciation for the intent and purpose of the off-the-shelf helicopter program as originally conceived and its benefit to the over-all aviation program, for I receive the student product from Fort Wolters for advanced helicopter training. I, therefore, feel very strongly that the mission suitability findings as submitted will totally defeat the intent of the off-the-shelf procurement program if acted upon without further evidence. Further, I am convinced there is nothing to be gained by procuring the helicopters manufactured by Company B and Company C as primary trainers at a cost equal to or greater than the tactical helicopters now being used in the primary training program.

3. While I feel that the evaluation conducted by the U. S. Army Aviation Test Board and the U. S. Army Primary Helicopter School was thorough, complete and factual, I do not feel that the evaluation was sufficiently deep in scope to establish without doubt that the primary helicopter training mission could not be achieved with a light, inexpensive machine.

AJRCG 8 November 1963

SUBJECT: Report of Test, USATECOM Project No. 4-3-1000-01-A, Military Potential Test of Commercial "Off-the-Shelf" Helicopters as Primary Helicopter Trainers

4. Further, I am firmly convinced that any decision to disallow further consideration of the inexpensive helicopter based on the findings of this evaluation would be premature. Such decision would be indefensible from the mission suitability standpoint since the evaluation was too limited in scope and was conducted under controlled training conditions rather than in a true primary training atmosphere. In my opinion, a final decision as to the suitability or unsuitability of a light, inexpensive helicopter must be based on more positive information.

5. When the program for the procurement of an off-the-shelf primary trainer was approved by the Assistant Secretary of the Army, Installations and Logistics (ASA I&L), it was suggested that a safer course of action would be to procure a small number of machines for evaluation in an actual primary training class at Fort Wolters, Texas. Secretary Ignatius pointed out that this would be time consuming and result in a more costly program; however, he agreed that if a potentially suitable and more economical trainer were selected by the pre-procurement evaluation, but doubt existed as to its mission suitability, the initial quantities of these production helicopters would be used for further evaluation under primary helicopter training conditions. If, then, this evaluation resulted in a finding that the light, inexpensive machine is not suitable, procurement would be terminated.

6. In view of the foregoing, it is recommended that the second step of the procurement be implemented as planned, that the delivery schedule be planned so that the initial deliveries are scheduled to permit operation and evaluation in an actual primary class at Fort Wolters. The results of such an evaluation combined with the present finding will produce defensible, conclusive and factual evidence as to the suitability, durability and reliability of the light, inexpensive helicopter for use as an Army primary helicopter trainer. In addition, it will avoid creating a most embarrassing situation since the whole concept was used to justify the appropriation of money by the Congress.

Clifton F. von Kann

CLIFTON F. von KANN
Major General, USA
Commandant

## APPENDIX B

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10. Company A Report HTC-AD63-18, subject: Proposal for Primary Helicopter Trainer, 14 June 1963.

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12. Company A PH-1 Flight Operating Manual.

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15. Primary Helicopter Trainer Technical Report, PH-5, 47-099-022, 28 June 1963.

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24. Company A, Report HTC-63-28, subject: Detail Specification PH-9 Primary Helicopter Trainer, 12 September 1963.

25. PH-9 Flight Handbook.

AD-A033 205 ARMY AVIATION TEST BOARD FORT RUCKER ALA F/G 1/3
MILITARY POTENTIAL TEST OF COMMERCIAL 'OFF THE SHELF' HELICOPTE--ETC(U)
JAN 64 W S DAVIS, H G SMITH

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US Army Aviation Test Board, Ft. Rucker, Alabama. Military Potential Test of Commercial Off-the-Shelf Helicopters as Primary Helicopter Trainers. Final report, 20 November 1963. USATECOM Project No. 4-3-1000-01-A. 312 pp., 6 illus. Unclassified report. Six helicopters (PH-1, PH-4, PH-5, PH-6, PH-7, and PH-9) were tested to determine which commercial off-the-shelf FAA-certificated helicopters were suitable for use as primary helicopter trainers. It was concluded that the PH-4, PH-5, PH-6, and PH-7, after correction of the deficiencies and shortcomings listed in this report, will be suitable for Army use as primary helicopter trainers, but do not meet the essential objective of low cost; and that the PH-1 and PH-9, after correction of the deficiencies and shortcomings listed in this report, may be suitable for Army use as primary helicopter trainers. However, further evaluation would be necessary in the training environment of the USAPHS at Fort Wolters, Texas, before final determination of their suitability for the training mission requirement can be made. It was recommended that the PH-4, PH-5, PH-6, and PH-7, after correction of the deficiencies and shortcomings listed in this report, be considered qualified for step two of the procurement program; and that the PH-1 and PH-9, after correction of the deficiencies and shortcomings listed in this report, be considered qualified for step two of the procurement program with the understanding that if one is successful, final determination of its suitability for the training mission requirement be made by the USAPHS after further evaluation at Fort Wolters, Texas.

AD_____Accession No. _____

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